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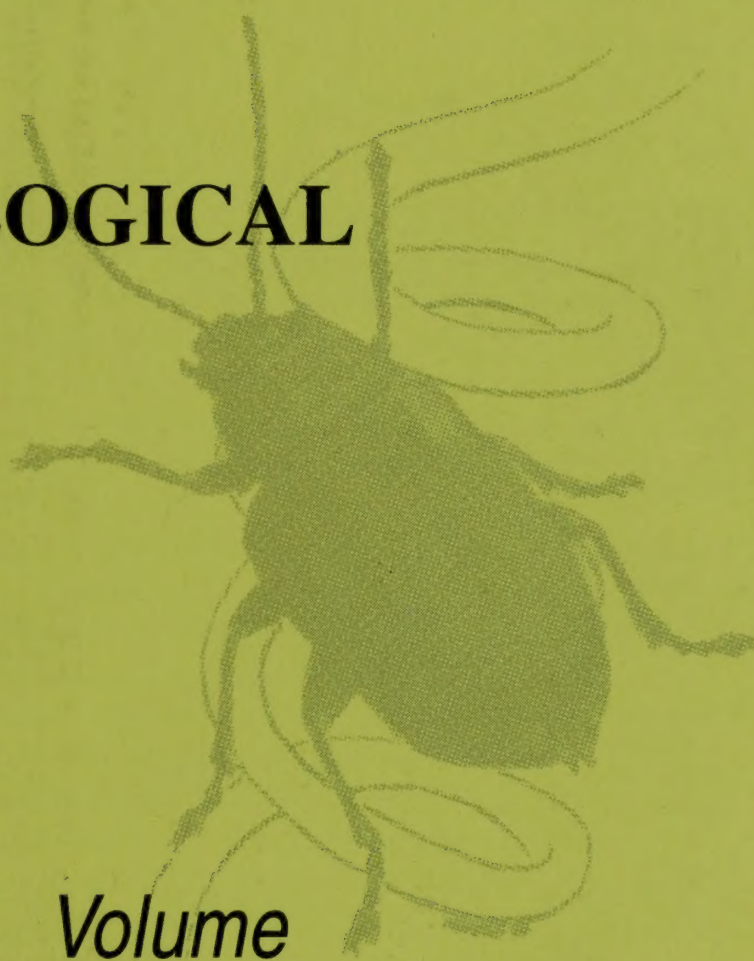
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**JOURNAL**  
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**From the Editor,**

The big news is that our periodical has a new name; it is now the Journal of the Entomological Society of Ontario. The Society's Board approved the name change at the Ottawa Annual Fall Meeting in 2002 to reflect that our society's publication is a refereed work. The word "Proceedings" in the old title had a negative connotation suggesting the work was an unreviewed publication of our annual meeting. With the plethora of new scientific journals increasing the competition for manuscripts, it was important for our Society to give our publication a new image. Of course, we will continue to publish only high quality refereed articles and the new name will poise the Journal for continued success well into the 21st century and beyond.

Coleoptera and agricultural pest insects were the two main subjects treated in this issue. LeSage offered an important paper on the biology and identification of two grape pests, the grape flea beetle and the lesser grape beetle. This work should be of interest to grape entomologists in North America. Gill and Vaz-de-Mello identified an unusual new species of Scarabaeidae from Colombia. McDonald *et al.* explore onion breeding lines for resistance to onion maggot, while McIntyre *et al.* report on the contact toxicity of two insecticides to the striped cucumber beetle. Finally, books on Carabidae and Chrysomelidae published by Intercept Limited were reviewed.

Many thanks are due to our cover artist, M. Damus, for his skill in depicting the grape flea beetle hanging from a grape tendril. I also welcome Ms. K. Jamieson, our new technical editor, and Ms. J. Scott Barsanti, our new layout artist, who have joined the production team. I know their learning curves were large, and I think you will agree with me that they have mastered their roles. The scientific review could only have been accomplished with our panel of associate editors and the anonymous reviewers they selected. Serving as scientific editor for our journal is an honour and a pleasure, in that it allows me to meet new entomologists from across North America and it keeps me abreast of some of the research in entomology. I am looking forward to reading your manuscripts for volume 134.

Yves Prévost

Yves.Prevest@Lakeheadu.ca







## FLEA BEETLES OF THE GENUS *ALTICA* FOUND ON GRAPE IN NORTHEASTERN NORTH AMERICA (COLEOPTERA: CHRYSOMELIDAE)

LAURENT LeSAGE

Agriculture Canada, Agriculture and Agri-Food Canada, 960 Carling Ave.,  
Ottawa, Ontario, Canada, K1A 0C6 (e-mail: lesagel@agr.gc.ca)

*J. ent. Soc. Ont.* 133: 3–46

### Abstract

Two species of *Altica*, *A. chalybea* Illiger (Grape Flea Beetle) and *A. woodsi* Isely (Lesser Grape Flea Beetle), are described and treated in detail. A key is provided for their distinction. Information is given on their distribution, host-plants, parasites, predators, common names, economic importance, and control. Comments on misidentifications found in the literature are also provided.

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### Résumé

L'auteur décrit et traite en détail de deux espèces d'*Altica*, *A. chalybea* Illiger (Altise de la vigne) et *A. woodsi* Isely (Petite altise de la vigne), et propose une clé d'identification pour les déterminer. Il fournit également de l'information concernant leur répartition géographique, leurs plantes-hôtes, leurs parasites, leurs prédateurs, leur nom vernaculaire, leur importance économique et les moyens de lutte. Enfin, il commente les erreurs de détermination de la littérature.

### Introduction

There are three major leaf beetle pests on grape in the northeastern North America. The Grape Rootworm, *Fidia viticida* Walsh, 1867, occasionally causes important damage to cultivated varieties; the adults feed on foliage whereas the larvae are root feeders. The other two pests are species of the genus *Altica* Geoffroy, 1762: *A. chalybea* Illiger, 1807 and *A. woodsi* Isely, 1920.

The purpose of the present paper is to describe in detail, and illustrate, the adults of these latter two species. Both species being very important economically, misidentifications and confusions found in the literature are clarified. Since many common names have been attributed to these pests over the years, their proper uses are also discussed.

### Materials and Methods

The format and terminology of the descriptions, as well as the characters and the measurements provided here, are the same as those already used in my previous contributions to the revision of the North American species of the genus *Altica*, with the addition of notes on the contents of the citations in the literature review (LeSage 1995, 2000; LeSage and Denis 1999).

The following list of collection acronyms is in addition to those already given in LeSage (1995):

- CCC Claude Chantal (private) Collection. Association des entomologistes amateurs du Québec Inc., 302 Gabrielle Roy, Varennes, Québec, Canada J3X 1L8. c/o Claude Chantal.
- CFIM Collections en Fiducie de l'Insectarium de Montréal, Insectarium de Montréal, 4581 Sherbrooke Est, Montréal, Québec, Canada H1X 2B2. c/o Georges Brossard.



- EMEC Essig Museum of Entomology Collection, University of California, California Insect Survey, 201 Wellman Hall #3112, Berkeley, California 94720, USA c/o Cheryl B. Barr.
- UNHC University of New Hampshire Collection, Entomological Museum, University of New Hampshire, Department of Entomology, Nesmith Hall, Durham, New Hampshire 03824, USA c/o Donald S. Chandler.
- YPMC Yale Peabody Museum Collection, Peabody Museum of Natural History, Yale University, Entomology Division, 170 Whitney Avenue, PO Box 208118, New Haven, Connecticut 06520-8118, USA c/o Raymond Pupedis.

**Identification Key to *Altica* Flea-Beetles  
Feeding on Plants of the Family Vitaceae  
in Northeastern North America**

Before using the following key, it is assumed that the host-plants have been correctly identified. Although *Altica litigata* Fall does not feed on Vitaceae, it has been added to the key because it is externally very similar to *A. woodsi* Isely.

1. Pronotal transverse groove weakly impressed, not very distinct; host-plants not in the family Vitaceae (species not treated here) ..... 3'
- 1'. Pronotal groove deeply impressed and distinct throughout (Figure 1); host-plants usually in the family Vitaceae ..... 2
2. Size larger, usually over 4 mm long, body usually plumper (length/width body ratio on average less than 1.8), and colour usually dark metallic blue (Figure 1a).  
..... *A. chalybea* Illiger
- 2'. Size smaller, usually less than 4 mm long, body usually slender (length/width body ratio on average more than 1.8), and colour usually blue-green or blue with green reflections (Figure 1b) ..... 3
3. Male with tip of the aedeagus triangular and slightly nipple-shaped in the middle, ventral carina and longitudinal ridges well developed (Figure 2b); female with tip of the styli narrower and longer (Figure 3a); host-plants: *Vitis* spp. and *Parthenocissus* spp. ....  
..... *A. woodsi* Isely
- 3'. Male with tip of the aedeagus lanceolate, ventral carina and longitudinal ridges not visible; female with tip of the styli proportionally shorter and broader; host-plants: *Ludwigia* spp., *Oenothera* spp. .... *A. litigata* Fall

**Clé d'identification des Altises du genre *Altica*  
inféodées aux plantes de la famille des Vitaceae  
dans le Nord-Est américain**

La clé suivante fonctionnera à la condition que les plantes-hôtes aient d'abord été identifiées correctement. *Altica litigata* Fall, qui n'est pas inféodée aux Vitaceae, a néanmoins été ajoutée à la clé parce que cette espèce est très proche d'*A. woodsi* Isely.



- 1. Sillon transversal du pronotum peu profond, pas très distinct; plantes-hôtes n'appartenant pas à la famille des Vitaceae (espèces non traitées ici) ..... 3'
- 1'. Sillon transversal du pronotum profond et distinct sur toute sa longueur (figure 1); plantes-hôtes appartenant surtout à la famille des Vitaceae ..... 2
- 2. Taille plus grande, habituellement plus de 4 mm, corps plus dodu (ratio longueur/largeur en moyenne moins de 1,8), et couleur en général bleu métallique foncé (figure 1a) .....  
.....A. *chalybea* Illiger
- 2'. Taille plus petite, habituellement moins de 4 mm, corps plus allongé (ratio longueur/largeur en moyenne plus de 1,8) et couleur en général bleu-vert ou bleu avec des reflets verts (figure 1b) ..... 3
- 3. Chez le mâle, bout de l'édéage triangulaire et légèrement mamelonné au milieu, carène ventrale et crêtes longitudinales très bien développées (figure 2b); chez la femelle, bout des styles plus étroit et plus long (figure 3a); plantes-hôtes: *Vitis* spp. et *Parthenocissus* spp. ....  
.....A. *woodsii* Isely
- 3'. Chez le mâle, bout de l'édéage lancéolé, carène ventrale et crêtes longitudinales invisibles; chez la femelle, bout des styles proportionnellement plus large et plus court; plantes-hôtes: *Ludwigia* spp. et *Oenothera* spp. .... A. *litigata* Fall

1. *Altica chalybea* Illiger, 1807

*Haltica chalybea* Illiger 1807: 115 (original description); Harris 1833: 581 (list of Massachusetts animals); Melsheimer 1853: 121 (catalogue of United States Coleoptera); Fitch 1859a [1856]: 84 (annual report on insect pests of New York); Fitch 1859a [1858]: 63 (annual report on insect pests of New York); Fitch 1859b: 171 (answer to grower's question on grape pests); Larrowe 1862: 383 (answer to grower's question); Worden 1862: 350 (infestation in Oswego Co., New York); Walsh and Riley 1868: 27 (mentioned as pest); Riley 1870a: 309 (identification of grape pests); Riley 1870b: 327 (biology); Gott 1878: 45 (biology of fruit pests); Gott 1879: 58 (insect monitoring); Riley 1880: 183 (biology and control); Riley 1881: 53 (reference to *Graptodera*); Couper 1883: 219 (Québec fauna); Saunders 1883: 190, 277; 1889: 190, 277; 1900: 190, 277 (insects injurious to fruits); Harrington 1884: 82 (survey of Ottawa [Ontario] Coleoptera); Fletcher 1885: 26 (Ontario insect pest monitoring); Saunders 1885: 17 (annual address on various insects); Lintner 1888: 96 (comparison with *Altica bimarginata*); Osborn 1888: 162 (monitoring Iowa insect pests); Horn 1889: 220 (taxonomy of North American species); Riley 1889: 221 (compared to *Altica woodsii* [erroneously as *A. ignita*]); Lintner 1890: 188 (NY insect pests); Lintner 1891: 332, 353 (NY insect pests); Neal 1890: 11 (biological notes); Smith 1890: 225 (list of New Jersey insects); Schwarz 1892: 182 (Eastern United States fauna); Hamilton 1895: 340 (catalogue of Pennsylvania Coleoptera); Marlatt 1896: 395 (grape insect pests); Slingerland 1898: 189 (biology in New York); Blatchley 1896: 437 (winter fauna in Indiana); Lowe 1898: 263 (biology in New York); Lugger 1899: 241 (biology of Minnesota injurious insects); Felt 1900a: 555, 563, 564, 570, 573, 601 (grape pests monitoring in New York); Felt 1900b: 15 (injurious and beneficial insects in New York); Smith 1900: 312 (list of New Jersey insects); Felt 1901: 1005 (grape pests monitoring in New York); Felt 1902: 838 (grape pests monitoring in New York); Thomas 1906: 197 (fruit destructive insects); Bethune 1907: 35 (as *Haitica (sic) chalybea*, fruit-tree pests in Ontario);



Quaintance and Shear 1907: 23 (biology of grape insect pests); Hartzell 1910: 485 (biology in New York); Blatchley 1910: 1201 (Indiana fauna); Smith 1910: 552 (list of New Jersey insects); Wickham 1911: 32 (list of Iowa Coleoptera); Gibson 1913: 6 (flea beetle control in Canada); Reh 1913: 523 (handbook on beetle pests); Caesar 1914: 81 (Ontario grape pests); Slingerland and Crosby 1914: 403 (biology); Hartzell 1915: 201 (biology in New York); Hewitt 1915: 26 (control experiments); Caesar 1916: 31 (insects of the season in Ontario); Chagnon 1917: 243 (checklist of Québec Coleoptera); Duckett 1920: 138 (Maryland fauna); Fall 1920: 102 (taxonomic comparisons); Isely 1920: 4 (biology in Washington, D.C.); Leng 1920: 300 (catalogue of North American Coleoptera); Quaintance and Shear 1921: 26 (insect grape enemies); Cooper 1922: 388 (pests of Arkansas commercial grape); Quaintance and Shear 1922: 239 (insect grape enemies); Blatchley 1924: 20 (Florida fauna); Hartzell 1924: 82 (grape insects of New York); AAEE 1925: 526 (checklist of common names); Ross and Caesar 1925: (insects of the season in Ontario); Eyer and McCubbin 1926: 12 (grape insects of Pennsylvania); Hatch and Ortenburger 1926: 10 (list of Oklahoma Chrysomelidae); Ross 1926b: 188 (Niagara Peninsula grape insects); Britton 1927: 439 (summary on Connecticut insect pests); Britton 1928: 675 (Connecticut insect pests); Gibson 1928: 26 (flower and garden insect pests); Leonard 1928: 477 (New York insect checklist); Zappe 1928: 729 (Connecticut fruit pests); Dean 1930: 140 (grape pests in Kansas); Zappe 1930: 609 (summary of Connecticut fruit insects); Gibson 1934a: 30 (garden insects in Canada), Gibson 1934b: 32 (garden insect pests in Canada); Brimley 1938: 228 (list of North Carolina insects); Chagnon 1938: 163 (Québec fauna); Chagnon 1940: 316 (Québec fauna); Heikertinger and Csiki 1940: 237 (world catalogue); Peairs 1941: 322 (handbook on insect pests); Löding 1945: 134 (catalogue of Alabama Coleoptera); Blunck 1954: 325 (handbook of phytophagous beetles); Chagnon and Robert 1962: 316, 408 (Québec fauna); Taschenberg and Riedl 1985: 1 (grape pests in Northeastern North America); Syme and Nystrom 1988: 10 (Ontario forest insects).

*Chrysomela vitivora* Thomas 1834: 113 (original description); synonymy by Harris *vide* Herrick (1835: 420), quoted by Slingerland (1898: 213).

*Galleruca janthina* J.E. LeConte 1824: 173 (original description); Horn 1893: 132 (synonymy).

*Graptodera chalybea* (Illiger): Melsheimer 1853: 121 (Catalogue of the United States Coleoptera); Couper 1855: 326 (list of Canadian Coleoptera); Provancher 1877: 676 (Québec fauna); Comstock 1880: 213 (entomologist's report, United States, biology); Couper 1883: 219 (listed for Québec); Riley 1881: 53 (generic transfer); Harrington 1882a: 25 (pest monitoring); Harrington 1882b: 60 (pest monitoring); Bethune 1893: 10 (annual address on pests); Saunders 1883: 277; 1884: 207; 1889: 277; 1900: 277 (annual address); Bethune 1898: 31 (injuries in Ontario); McMillan 1888: 42 (biology in Nebraska); Townsend 1891: 7 (control of grape pests in New Mexico).

*Graptodera vitivora* Bell 1880: 66c (*nec* Thomas 1834: 113) (faunal survey; misidentification of *A. bimarginata* Say).

*Altica chalybea* Illiger: Britton 1920: 278 (checklist of Connecticut insects); Herrick 1925: 175 (manual on injurious insects); Britton 1926: 221 (monitoring Connecticut insect pests); Caesar and Ross 1926: 14 (insects of the season in Ontario); Caesar 1927 (grape insects of Ontario); Muesebeck 1942: 87 (insect common names); SPPQ 1947: 8 (insect common names); Ross and Armstrong 1949: 1 (biology and control in Ontario); SPPQ 1952: 8 (insect common names); Wilcox 1954: 446 (Ohio fauna); MacNay 1956: 116 (insect infestations in Canada); SPPQ 1964: 9 (insect common names); Forsythe and Still 1969: 35 (Ohio grape insect pests); Balsbaugh and Hays 1972: 148 (Alabama fauna); Wilcox 1975: 110 (checklist of North American species); Benoit 1975: 25 (Canadian insect common names); Campbell *et al.* 1989: 68 (biology of Canada beetle pests to crops); Benoit 1985: 10 (Canada insect common names); Kirk 1969: 96 (South Carolina beetle list, Coastal Plain); Kirk 1970: 72 (South Carolina beetle list, Piedmont); Still and Rings 1973: 8 (Ohio grape pests); Sutherland 1978: 19 (insect common names); Wilcox 1979: 25 (host-plants);



Werner 1982: 19 (insect common names); Wilcox 1983: 110 (catalogue of North American Chrysomelidae); Taschenberg and Riedl 1985: 2 (insect identification sheet); Syme and Nystrom 1988: 10 (Ontario forest insects); Borror *et al.* 1989: 460 (general textbook on insects); Stoetzel 1989: 71 (insect common names); Laplante *et al.* 1991: 99 (checklist of Québec beetles); LeSage 1991: 301 (Canadian fauna); Belton and Eidt 1996: 4 (Canadian insect common names) Dearborn and Donahue 1993: 67 (survey of Maine forest insects); Weigle and Kovach 1995: Sheet 6 (grape IPM in the Northeast); Downie and Arnett 1996: 1374 (Northeast fauna); Bosik 1997: 31 (insect common names); Staines and Staines 1998: 239 (survey of Plummers Island [Maryland] Chrysomelidae); Clark 2000: 32 (annotated list of West Virginia Chrysomelidae); Lasnier *et al.* 2001: 4 (Web site on Québec grape insect pests).

*Altica oleracea* Melsheimer 1806: 22, *nec oleracea* Linné 1758: 372 (misidentification *fide* Schwarz 1895: 136).

“Grape vine flea-beetle” or “grape flea-beetle”: Harris 1854: 11 (report on grape pests); Lowe 1898: 263 (life history in Geneva, New York); Gott 1879: 58 (annual insect registry in Ontario); Fletcher 1884: 7 (Ontario insect pests); Ross 1926a (Niagara Peninsula grape insects); MacNay 1955: 80 (insect infestations in Ontario); Still and Rings 1965: 18 (grape insect pests); McGrew and Still 1968:17, 1979: 19 (grape pest control in Eastern United States).

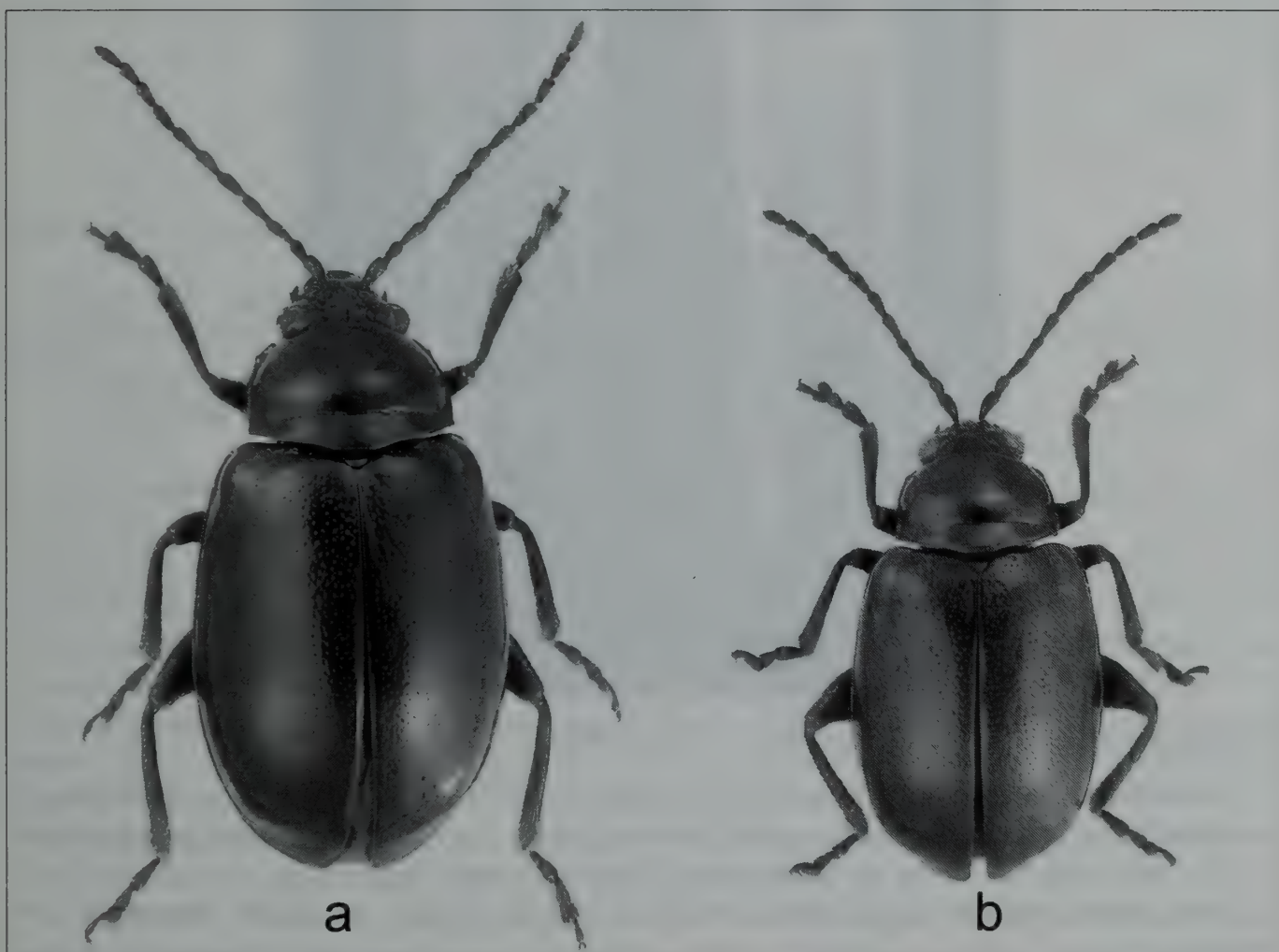


FIGURE 1. Habitus of adult, dorsal view. a, *Altica chalybea*; b, *A. woodsi*.

**Etymology.** The species name is derived from the Latin adjective *chalybeius*, meaning “made of steel”, in reference to the metallic blue colour of the body. However, three other variant spellings also exist according to Lorenz (1998): *chalibaeus*, *chalybaeus*, and *chalybe-us*, *-a*, *um*. Such variants are deemed to be identical according to the Code (ICZN 2000, Article 58.1).



I chose to follow Heikertinger and Csiki (1940) and used *chalybaea*, when I prepared the checklist of the Chrysomelidae of Canada (LeSage 1991), but did not notice the slight difference in spelling with that of the original description (*chalybea*). Although both variants are valid and equivalent, I will use the original spelling in the future.

**Diagnosis.** Colour metallic blue, shape oval, with a body length/width ratio on average less than 1.8, and pronotum with a deep transverse groove (Figure 1a).

In the male, tip of aedeagus triangular and nipple-shaped in the middle (Figure 4); lateral and ventral wrinkles oblique and fused together, ventral ridges short, 1/5 length of aedeagus (Figure 4b).



FIGURE 4. Aedeagus of *Altica chalybea*: a, dorsal view; b, ventral view.

In the female, receptacle of spermatheca almost cylindrical; basal portion of the spermathecal duct usually long, and median portion coiled into two loops (Figs. 5a-d); styli fused together for 4/5 their length, with their inner margins acutely diverging at apex (Figure 5a).

Host-plants restricted to the genera *Vitis* and *Parthenocissus* in the family Vitaceae (grape family).

**Traits distinctifs.** Corps bleu métallique, ovale, avec un ratio longueur/largeur, inférieur à 1,8, en moyenne, et un pronotum à sillon transverse profond (Figure 1a).

Chez le mâle, bout de l'édéage triangulaire et mammelonné au milieu (Figure 4); plis latéraux et ventraux obliques et fusionnés ensemble; arêtes ventrales courtes, 1/5 de la longueur de l'édéage (Figure 2b).



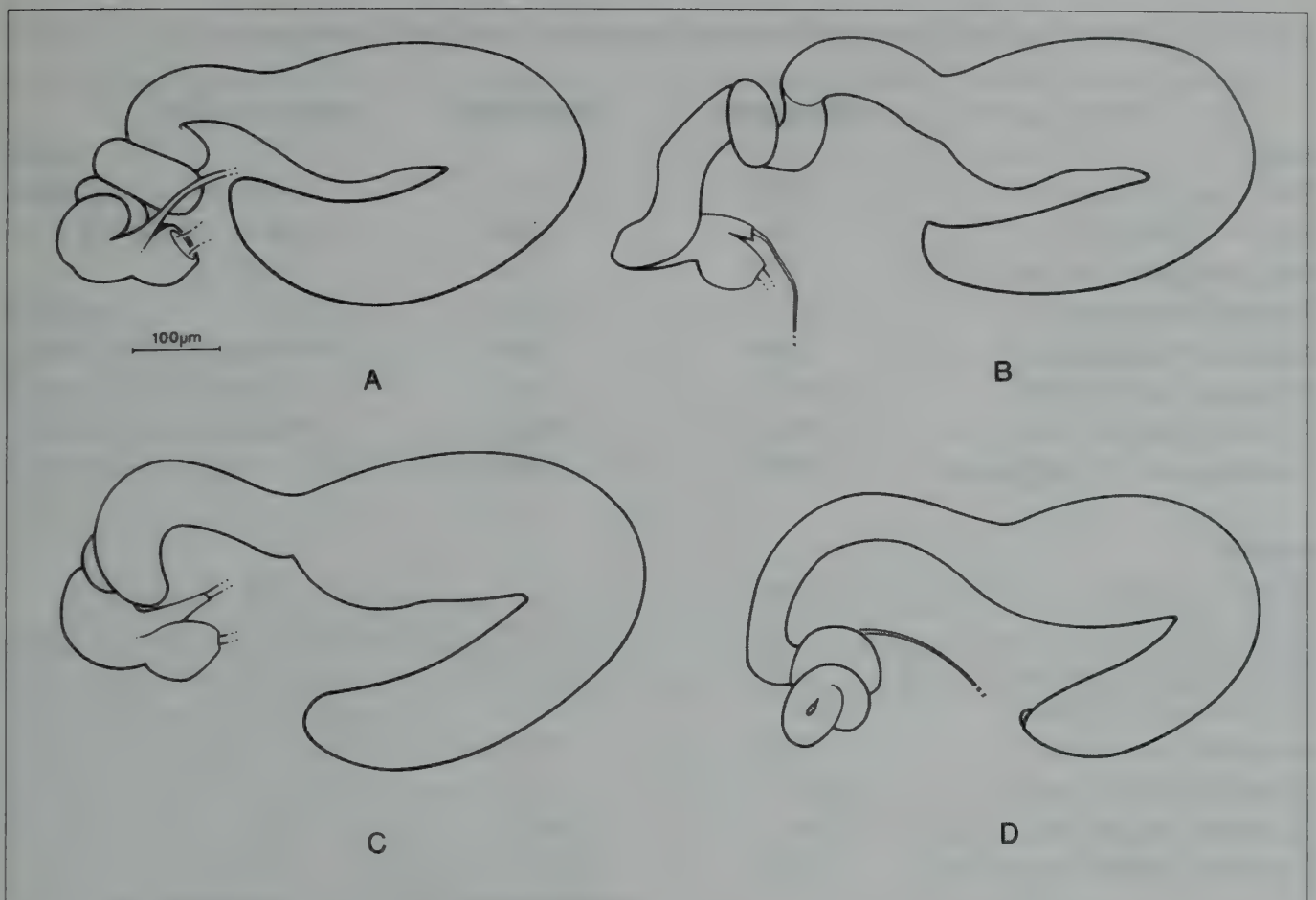


FIGURE 5. Variations of the spermatheca in *Altica chalybea*: a-d.

Chez la femelle, réceptacle de la spermathèque presque cylindrique; portion basale du canal spermathéal allongée, portion médiane à two boucles Figure 5a-d); styles fusionnés sur 4/5 de leur longueur, leurs marges internes écartées à angle aigüe Figure 5a).

Plantes-hôtes restreintes aux genres *Vitis* et *Parthenocissus* de la famille des Vitaceae.

**Description.** BODY. Medium-sized species, 3-5 mm long, distinctly ovoid with body length/width ratio usually less than 1.8 (Figure 1a) (Table I).

HEAD. *Antennae* moderately long about half length of body, proportionately longer in males than in females (Table I); antennomeres 3 and 4 subequal in length, but both distinctly longer than 2. *Frontal carina* moderately sharp, very finely punctulate, ending in middle of frontal tubercles. *Frontal tubercles* smooth, more or less well-defined posteriorly by frontal grooves; median frontal groove, between tubercles, moderately long (95% of specimens examined,  $n = 20$ ), rarely not visible (5%). *Vertex* smooth on disc, with few coarse punctures behind eyes. *Eyes* separated by 2.5 times their diameter, not prominent. *Postocular macrochaetae*: 1. *Labral setae*: 6. *Mandibles* with outer tooth small (Figure 6c) or lacking (Figure 6b), median tooth of moderate size, inner tooth with indentation at base; cutting edge not produced at apex.

THORAX. *Pronotum* quadrate, slightly narrower at apex than at base (Figure 1a). *Anterior angles* of pronotum not prominent, obliquely truncate. *Transverse groove* of pronotum deep throughout. *Punctuation* of pronotum fine and moderately dense. *Microsculpture* of pronotum apparently absent at low magnification, but weakly impressed and distinct. *Legs* of same colour as body. *Tarsal claws* appendiculate, moderately bent.

ELYTRA. *Umbones* moderately prominent and defined on inner side by small depression. *Elytral costa* absent. *Punctuation* moderately dense, coarser than that of pronotum, and slightly finer at apex than at base. *Microsculpture* weakly impressed but distinct.



TABLE I. Measurements of body, antennae and pronotum in *Altica chalybaea*.

	Minimum	Maximum	Mean (n =10)
<b>Male</b>			
Body length (mm)	2.9	4.7	4.3
Body width (mm)	2.1	2.6	2.5
Body length/ width ratio	1.39	1.90	1.76
Antenna length (µm)	220	290	269
Antenna/ body ratio	0.58	0.77	0.63
Pronotum width (µm)	136	177	157
Pronotum length (µm)	88	106	101
Pronotum width/ length ratio	1.36	1.67	1.55
<b>Female</b>			
Body length (mm)	4.45	5.3	4.8
Body width (mm)	2.6	2.9	2.7
Body length/ width ratio	1.67	1.94	1.77
Antenna length (µm)	265	290	274
Antenna/ body ratio	0.53	0.61	0.57
Pronotum width (µm)	160	182	170
Pronotum length (µm)	96	110	105
Pronotum width/ length ratio	1.55	1.73	1.62

SEXUAL DIMORPHISM. (Table I) *Body* slightly more elongate in male than in female. *Antennae* proportionately longer in male than in female. *First tarsomeres* of front legs distinctly broader in male than in female.

MALE GENITALIA. (Table II) *Median lobe* of aedeagus slightly broadened in apical third in dorsal view (Figure 4a); *tip* triangular, nipple-shaped in middle; *dorsal undulations* distributed on 1/3 length of aedeagus; *ventral longitudinal ridges* not much elevated, short, not exceeding 1/5 length of aedeagus; *lateral* and *ventral wrinkles* oblique and fused together (Figure 4b).

FEMALE GENITALIA. (Table II) *Receptacle* of spermatheca almost cylindrical, slightly broader at base (Figure 5); *spermathecal pump* cylindrical, extending little beyond base of receptacle; *apical process* usually (95% of specimens examined, n= 20) absent (Figures 5a-c), or small (Figure 5d); *spermathecal valve* moderately developed; basal portion of *spermathecal duct* varying from short (Figures. 5a), to moderately long (Figures. 5b, 5c), to long (Figure 5d); median portion coiled into 2 loops; *styli* fused together on 4/5 their length with inner margins acutely diverging at apex (Figure 6a).

**Remarks.** Although *Altica chalybea* appears plumper than most species of the genus, this character is quite variable (Table I), and consequently, the identification should be confirmed by examining the genitalia.

With regards to size, Floridian specimens are often larger than average, and, in addition, individuals are sometimes entirely purple instead of blue; on the other hand, their genitalia are indistinguishable from those of northeastern individuals. This larger size and different colour might be significant enough to justify the creation of a distinct subspecies, but more material is needed to measure the extent and value of these variations.



TABLE II. Measurements of male and female genitalia in *Altica chalybea*

	Minimum	Maximum	Mean (n =10)
<b>Male</b>			
Aedeagus length (μm)	160	176	168
Ventral oblique wrinkles	14	21	19
<b>Female</b>			
Spermatheca length (μm)	288	333	310
Length of styli (μm)	425	538	480
Apical setae on styli	10	15	12
Sensilla on styli	8	16	12

In the field, *Altica chalybea* and *A. woodsi* are often found simultaneously on the same host-plant. In these circumstances, most individuals can be readily recognized with the naked eye by their size and colouration, those of *A. chalybea* being larger and deep blue whereas those of *A. woodsi* are smaller and blue-green.

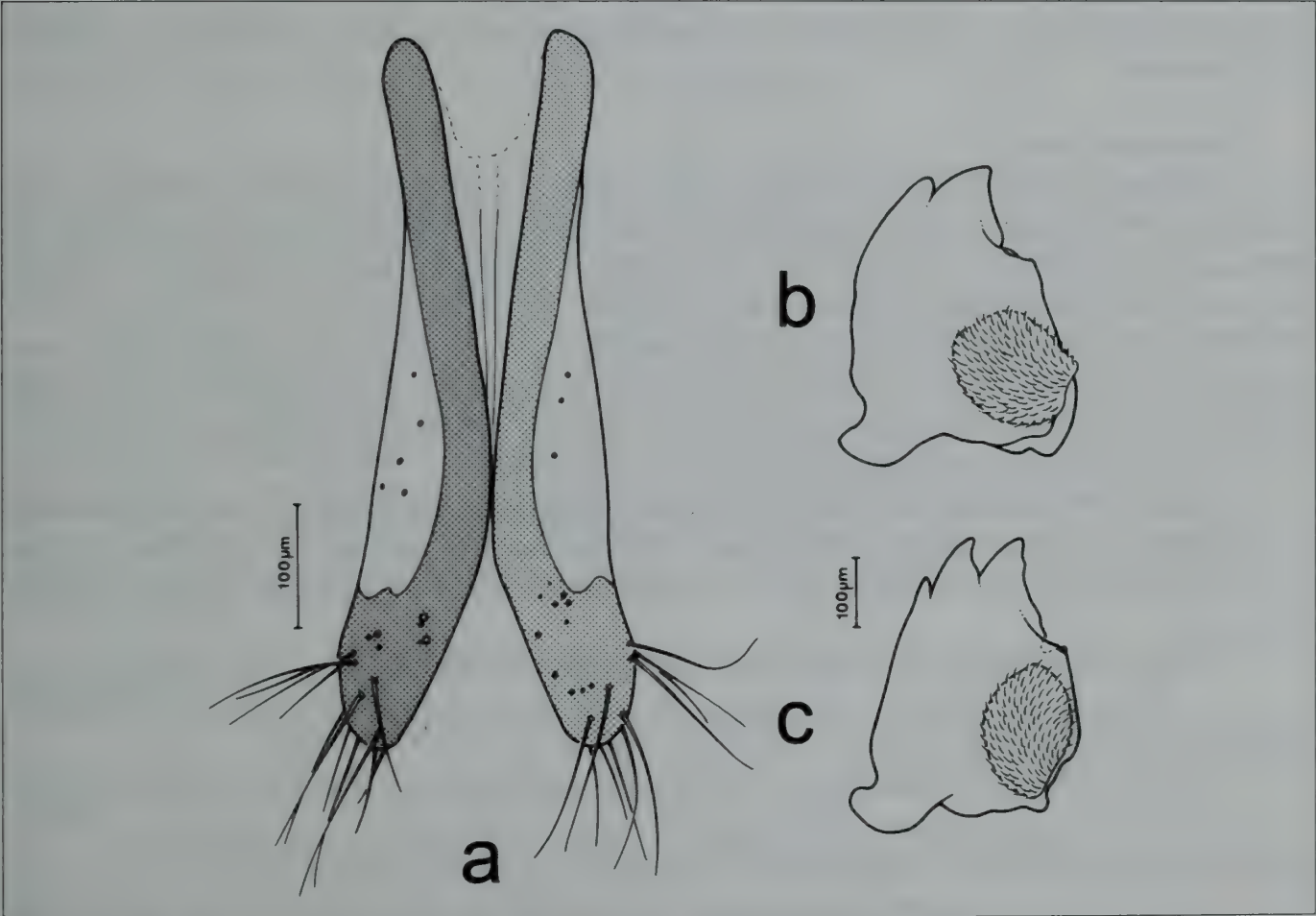


FIGURE 6. *Altica chalybea*: a, styli; b-c, mandible.



**Type material.**

*Haltica chalybea* Illiger, 1807.

The type series of *Haltica chalybea* is preserved in the A.S. Knoch Collection in the Museum für Naturkunde der Humbolt-Universität zu Berlin in Germany. It consists of six specimens that have been discussed and lectotypes designated by LeSage (2000). The type locality is Francillon, in Georgia (USA).

*Galleruca janthina* J.E. LeConte, 1824.

P. Perkins (pers. comm.), curator of the MCZ entomological collection where J.L. LeConte's collection is housed, informed me that no type specimens could be found. According to my colleague Yves Bousquet, the collection of J.E. LeConte (father) is probably lost. However, since, LeConte's original description is sufficiently detailed, and the colour plate good enough to allow a reliable determination of the species (J.E. LeConte 1824: 173; plate XI, Figure 16), there is no need to designate a neotype. I follow here the recent recommendations (75.2) of the Code (ICZN 1999): "A neotype is not to be designated as an end in itself, or as a matter of curatorial routine, and any such neotype designation is invalid. If an author designates a neotype for *Xus albus* Smith, a species about whose identity there is no doubt and which is not involved in any complex zoological problem at the time at which it was designated, the purported "neotype" has no name-bearing status".

*Chrysomela vitivora* Thomas, 1834.

The types, if they exist, could not be located. The type locality is not specified by the author, but corresponds very likely to Central New York according to a statement of Comstock (1880: 214). For the same reason as above, there is no need to designate a neotype. In addition, it would be for a synonym.

**Literature errors.**

— Harris (1854: 11). Under the name "Grape-vine flea-beetle or *Haltica*", Harris included two species. The damages to grape definitely concern *Altica chalybea* but those on alder should be attributed to *A. ambiens alni* Harris. It is impossible to be entirely sure of the identity of these species because no voucher specimens were preserved.

*Altica* species are largely mono- or oligophagous, and very similar externally. Host-plants like alder or grape are easy to identify, even by people in general. Consequently, I believe that authors have correctly identified the host-plants, but have misidentified the beetles feeding on them. This interpretation also applies to the cases reported below.

— Fitch (1859a [1856]: 84) reported that "this sometimes invades the plum also, as mentioned p. 362, and it also infests the elm and the alder". The species on plum cannot be identified, but elm is the only host of *Altica ulmi* Woods, and *A. ambiens alni* Harris is monophagous on alder (LeSage 1995: 315).

— Fitch (1859a [1858]: 63) stated that "the Grape-vine flea beetle, a very small greenish-blue or purple jumping beetle, ... also inhabit the elm, eating the leaves", very likely concerns *Altica ulmi*, not *A. chalybea*.

— Riley (1870b: 327) claimed that "the grape-vine flea beetle is found in all parts of the United States and in the Canadas, and it habitually feeds on the alder (= *Alnus serrulata*), as well as upon the wild and cultivated Grape-vine". His statement on the distribution is partly wrong since *Altica chalybea* does not occur west of Ontario in Canada, nor in several western states in the United States (Figure 7). The host-plant *Alnus serrulata*, now considered a variety of *Alnus rugosa* (Du Roi) Spreng. *fide* Scoggan (1978: 589), has been recognized as the unique host-plant of *A. ambiens alni* Harris by LeSage (1995: 316), whereas *A. chalybea* is restricted to *Vitis* and *Parthenocissus*.





FIGURE 7. Distribution of *Altica chalybea* in North America.

— Saunders (1883: 279; 1889: 279; 1900: 279) reported that “besides the vine, they feed on the Virginia creeper, *Ampelopsis quinquefolia*, and the alder, *Alnus serrulata*, and sometimes eat the leaves of the plum-tree”. This refers to at least three species: *Altica chalybea* for the Virginia creeper, *A. ambiens alni* for the alder, and a third one on plum which cannot be identified.

— McMillan (1888:75) stated that “It seems to have devoted itself largely to seedling apples, pears, quince, and plum trees... In July Mr. S. Barnard, of Table Rock, Secretary of the Horticultural Society, wrote as follows: A small bright green fly, or bug, which can either fly or hop, has damaged apple grafts and yearling trees”. The beetles mentioned were very likely an *Altica*, but probably not *A. chalybea*. At this moment, it is impossible to determine which species might be involved.

— Saunders (1883: 279; 1889: 279; 1900: 279). This author repeated Riley’s observation, cited above, by giving *Alnus serrulata* as a host-plant of *Altica chalybea*. See the comments in the paragraph above.

— Britton (1898: 316) reported that plum leaves were eaten by *Altica chalybea* which, very likely, has been misidentified.

— Lowe (1898: 263) and Britton (1898: 316) attributed to *Altica chalybea* “that the eggs are placed in clusters on the under side of the leaves” whereas it is the typical oviposition habits of *A. woodsi*.

— Felt (1900a: 602) reported “*Haltica chalybea* Ill under bark of elm, 8 Nov.” In my opinion, this statement more likely refers to *Altica ulmi*.



**Locality records from specimens examined.**

The following list is based on the examination of 1185 specimens.

Rhode Island, Kentucky, Tennessee, Mississippi, Louisiana, Utah and California represent new state records.

The literature records from Maine, Vermont, Arkansas, Minnesota, Nebraska and New Mexico mentioned below have not been corroborated during the course of this study. The first four of these states listed above fit well into the known distribution of the species (Figure 7), but the last two remain questionable until they have been confirmed by voucher specimens.

**CANADA**

**Ontario.** *Brant Co.*: Ohsweken (SAMC) 2; *Carleton Co.*: Gloucester (CFIM) 2, Nepean (CFIM) 1, North Gower/ Marlborough Forest (CFIM) 2, Ottawa (MZELU), E Smiths Falls and N Burritts Rapids (CFIM) 1; *Essex Co.*: Point Pelee National Park (SAMC) 1, / Visitor's Centre (SAMC) 9, Windsor (SAMC) 2; *Grey Co.*: Owen Sound (SAMC) 1; *Hastings Co.*: Belleville (SAMC) 1, Georgetown/ Halton Hills (SAMC) 1; *Kent Co.*: Chatham (UBCC) 4; *Lambton Co.*: Arkona (SAMC) 1, Pinery (Provincial) Park (SAMC) 36; *Middlesex Co.*: London (SAMC) 2; *Northumberland Co.*: Dundas (SAMC) 1, Ferris Provincial Park (CFIM) 1, Freelon (SAMC) 1, Mountsberg (SAMC) 1; *Renfrew Co.*: Long Point (SAMC) 1; *Simcoe Co.*: Simcoe (SAMC) 1; *Waterloo Co.*: Cambridge (SAMC) 1; *Wellington Co.*: Aberfoyle (SAMC) 1, Guelph (SAMC) 15, / University of Guelph (SAMC) 3, / (University of Guelph) Arboretum (SAMC) 1; *York Co.*: Keswick (SAMC) 1, King City (SAMC) 2.

Reported from this province by Harrington (1882a: 25; 1882b: 60; 1884: 82), Saunders (1883: 277; 1884: 207; 1889: 277; 1900: 277), Fletcher (1884: 7; 1885: 26), Bethune (1893: 10; 1898: 33), Hartzell (1910: 497), Gibson (1913: 6), Isely (1920: 2), Ross (1926a: 30; 1926b: 188), Caesar (1927: 44), MacNay (1955: 80; 1956: 116), Syme and Nystrom (1988: 10), LeSage (1991: 318) and Downie and Arnett (1996: 1374).

**Québec.** *Deux-Montagnes Co.*: Oka (CCC) 1; *Gatineau Co.*: Aylmer (CFIM) 60, Parc de la Gatineau/ Lac des Fées (CFIM) 1, / Lac Brown (CFIM) 2; *Huntingdon Co.*: Havelock (LEM) 1, Saint-Anicet (LEM) 2; *Iberville Co.*: Iberville/ Vignoble Dietrich-Jooss (CFIM) 1; *Île-de-Montréal Co.*: Communauté Urbaine (de Montréal) (USNM) 1; *Lévis Co.*: Saint-Nicolas (CFIM) 1; *Pontiac Co.*: Norway Bay (LEM) 1, (CFIM) 1; *Soulanges Co.*: Coteau-du-Lac (LEM) 1; *Vaudreuil Co.*: Rigaud (LEM) 5, (CFIM) 6.

Reported from this province by Provancher (1877: 676); Couper (1883: 219), Chagnon (1938: 163; 1940: 316), Chagnon and Robert (1962: 316, 408), LeSage (1991: 318), Laplante *et al.* (1991: 99) and Downie and Arnett (1996: 1373).

**UNITED STATES**

**Alabama.** *Baldwin Co.*: Oak Pond Branch E of Foley (NDSU) 2; *Dale Co.*: Fort Rucker Military Reserve (RHTC) 7; *Hale Co.*: Payne Lake NE of county (USNM) 1; *Houston Co.*: Chattahoochee State Park (UMMZ) 3, 1 mi. N Wicksburg (RHTC) 3; *Madison Co.*: Huntsville/ Monte Sano State Park (USNM) 1; *Washington Co.*: Calvert (CUIC) 1. Not located: Birmingham (as "B'ham") (FMNH) 1 (several possible counties).

Reported from this state by Löding (1945: 134), Balsbaugh and Hays (1972: 148), Downie and Arnett (1996: 1374).

(**Arkansas**). Reported from this state by Isely (1920: 6), Cooper (1922: 388), but not confirmed here by examined specimens.

**California.** *San Diego Co.*: Guadeloupe Island (as "Guadlpe Is.") (MCZ) 1.

**Colorado.** State record only: (USNM) 1; *Denver Co.*: Denver (MCZ) 1.



Reported from this state by Herrick (1925: 175) as “found from Massachusetts to Colorado”.

**(Connecticut).** Reported from this state by (Thomas 1834: 15) as *Chrysomela vitivora*, Hartzell (1910: 498), Britton (1920: 278; 1926: 221; 1927: 439; 1928: 675), Isely (1920: 6) and Zappe (1928: 729).

**District of Columbia.** District record only: (USNM) 1, Anacostia (USNM) 1, Washington (USNM) 2, (UMMZ) 1, / Rock Creek Park (USNM) 3.

Reported from this district by Isely (1920: 6).

**Delaware.** *New Castel Co.:* Newark (UMMZ) 1.

Reported from this state by Hartzell (1910: 497) and Isely (1920: 6).

**Florida.** State record only: (USNM) 1; *Alachua Co.:* county record only (UMMZ) 1, Chantilly Acres (USNM) 1, Gainesville (NDSU) 2, (UMMZ) 5, (USNM) 1, San Felasco Hammock (UMMZ) 1; *Bradford Co.:* Starks (SMCC) 2; *Charlotte Co.:* Charlotte Harbor (as “ChrlotteH”) (MCZ) 1, Salona (SMCC) 1; *Dade Co.:* county record only (UMMZ) 1, Biscayne (MCZ) 1, 4 mi S Homestead (FAMU) 1; Miami (UMMZ) 1, (USNM) 8, / *Hialeah* (USNM) 1; *Dixie Co.:* Old Town (USNM) 5; *Franklin Co.:* Saint Teresa Beach (FAMU) 1; *Highlands Co.:* Lake Placid/ Archbold Biological Station (RHTC) 5, (USNM) 1; *Holmes Co.:* 0.8 mi. SW Leonia (RHTC) 1; *Indian River Co.:* county record only (UNHC) 1, 2.5 mi. SE Wabasso (RHTC) 2; *Jackson Co.:* county record only (CCC) 1, Florida Caverns State Park (RHTC) 1, near Mariana (SMCC) 1; *Jefferson Co.:* county record only (USNM) 1; *Laluoka Co.:* Lake Okefenokee (as “Lake Oke.”) (PURC) 1; *Leon Co.:* Tallahassee (NDSU) 3, (SMCC) 1; *Liberty Co.:* Torreya State Park (RHTC) 1, (UMMZ) 3; *Marion Co.:* Ocala (RHTC) 3, Ocala National Forest (FAMU) 1; *Monroe Co.:* Key Largo (RHTC) 5, (USNM) 4, North Key Largo (EGRC) 1; *Orange Co.:* Goldenrod (SMCC) 3, Orlando (SMCC) 3, (USNM) 1, / *Strickland* (USNM) 1; *Palm Beach Co.:* Lake Worth (USNM) 1; *Pinellas Co.:* Belleair (MCZ) 1, Dunedin (CUIC) 6, (PURC) 6, (SMCC) 4; *Sarasota Co.:* county record only (PURC) 1, Laurel (SMCC) 6, / *Siesta Beach* (SMCC) 3, 2 mi. E Venice (SMCC) 8; *Seminole Co.:* Highway 441 at Seminole/ Lake county line (RHTC) 1, Sanford (USNM) 1; *St. Johns co.:* St. Augustine (MCZ) 3; *St. Lucie Co.:* St. Lucie (USNM) 1; *Suwannee Co.:* 5 mi. N Welborn (SMCC) 2; *Taylor Co.:* 11 mi. SW Steinhatchee (UNHC) 1; *Volusia Co.:* Enterprise (MCZ) 2, (UMMZ) 2, (USNM) 2, / *New Smyrna* (Beach) (USNM) 2; *Walton Co.:* Highway 185/ 1 mi. SW Holmes Co. (RHTC) 3.

County not specified (several possibilities): Paradise Key (USNM). Not located: “Link Port” (UNHC) 1, “Royal Palm Park” (PURC) 1, “Sunfall” (PURC) 1.

Reported from this state by Horn (1889: 220), Neal (1890: 10) as “Michigan to Florida”, Hartzell (1910: 497), Slingerland and Crosby (1914: 403), Isely (1920: 6), Leng (1920: 300), Herrick (1925: 175) as “south to Florida and New Mexico”, Wilcox (1975: 100), and Downie and Arnett (1996: 1373).

**Georgia.** *Chatham Co.:* Savannah (MCZ) 1; (UMMZ) 1; *Decatur Co.:* county record only (UMMZ) 1; *Pike Co.:* county record only (USNM) 13.

Not located: Chester Island (CUIC) 1, Georgia State College (CUIC) 1, (USNM) 1.

Reported from this state by Illiger (1807: 115), LeConte (1824: 173) as *Gallerucida janthina*, Comstock (1880: 214) citing Illiger (1807: 115), Hartzell (1910: 497), Isely (1920: 6) and LeSage (2000: 233).

**Illinois.** *Cook Co.:* Cicero (USNM) 5, Evanston (FMNH) 2, La Grange (USNM) 2, Riverside (UMMZ) 2, (USNM) 3; *Mason Co.:* Havana (USNM) 1; *St. Louis Co.:* county record only (UMMZ) 1; *Vermilion Co.:* Danville (SMCC) 2.

Reported from this state by Blatchley (1910: 1201), Hartzell (1910: 497) and Isely (1920: 6).

**Indiana.** *Allen Co.:* county record only (PURC) 1; *Clark Co.:* county record only (PURC) 1, State Forest (PURC) 1; *Crawford Co.:* county record only (PURC) 2; *Davies Co.:* county record only (PURC) 1; *Johnson Co.:* county record only (PURC) 1; *Kosciusko Co.:* county record only



(PURC) 1; *Laporte Co.*: county record only (PURC) 1; *Marion Co.*: county record only (PURC) 2; *Montgomery Co.*: Shades State Park (EGRC) 1; *Orange Co.*: county record only (PURC) 1; *Parke Co.*: county record only (LEM) 7; *Perry Co.*: county record only (PURC) 1; *Posey Co.*: county record only (PURC) 2, New Harmony (FMNH) 4; *Putnam Co.*: county record only (PURC) 1, Lieber State Park, 30 mi. W Indianapolis (CUIC) 14; *Starke Co.*: county record only (PURC) 2; *Tippecanoe Co.*: county record only (PURC) 8, Lafayette (FMNH) 1; *Vigo Co.*: county record only (PURC) 1; *Warren Co.*: county record only (PURC) 2.

Not located: Hickory Creek (FMNH) 1.

Reported from this state by Hartzell (1910: 497), Isely (1920: 6) and Blatchley (1910: 1201).

**Iowa.** *Henry Co.*: 5 mi. SW Mount Pleasant (TAMU) 1; *Johnson Co.*: Iowa City (USNM) 2; *Story Co.*: Ames/ Iowa State University (as "ISU") main campus (UMMZ) 1.

Reported from this state by Osborn (1888: 162), Wickham (1911: 32), Hartzell (1910: 497) and Isely (1920: 6).

**Kansas.** *Atchison Co.*: county record only (SEM) 1; *Douglas Co.*: county record only (SEM) 2, 16.5 mi. SE Lawrence (SEM) 1; *Riley Co.*: Popenoe (WFBM) 1.

Reported from this state by Quaintance and Shear (1907: 24; 1921: 27), Slingerland and Crosby (1914: 403), Isely (1920: 6) and Dean (1930: 140).

**Kentucky.** *Carter Co.*: Horton Flat near Grayson Lake (SMCC) 1; *Franklin Co.*: Frankfort (USNM) 1; *Henderson Co.*: Henderson (UMMZ) 3; *Menifee Co.*: Frenchburg (SMCC) 1, Red River/ Highway 77 (SMCC) 1; *Trigg Co.*: Golden Pond land between the Lake Recreation Area (CFIM) 1.

**Louisiana.** *East Baton Rouge Co.*: Baton Rouge (UMMZ) 1, (USNM) 2; *St. Landry Co.*: Opelousas (USNM) 1.

**(Maine).** Reported from this state by Dearborn and Donahue (1993: 67), but not confirmed here by specimens examined.

**Maryland.** *Baltimore Co.*: Stevenson (WFBM) 1; *Calvert Co.*: Chesapeake Beach (USNM) 12, Plum Point (USNM) 4; *Howard Co.*: Long Corner (USNM) 1; *Kent Co.*: Massey (CFIM) 3; *Montgomery co.* county record only (USNM) 1, Cabin John Bridge (as "Cab.JohnBr") (USNM) 1, Glen Echo (USNM) 22, Great Falls (USNM) 4, Plummers Island (USNM) 5; *Prince George's Co.*: Beltsville (USNM) 1, Bowie (USNM) 2, College Park (UCR) 1, Largo (USNM) 2, Riverdale (USNM) 1; *St. Mary's Co.*: Wailes Bluff (USNM) 1.

Reported from this state by Hartzell (1910: 497), Isely (1920: 6), Staines and Staines (1998: 239) and Downie and Arnett (1996: 1373).

**Massachusetts.** State record only (MCZ) 2; *Bristol Co.*: Berkley (MCZ) 1, Fall River (MCZ) 1; *Essex Co.*: Newburyport (UNHC) 1; *Hampden Co.*: Montgomery (USNM) 1; *Hampshire Co.*: Cummington (USNM) 1; *Middlesex Co.*: Bedford (UMMZ) 2, Cambridge (as. "Cambr.") (USNM) 1; *Norfolk Co.*: Stoughton (USNM) 1; *Plymouth Co.*: county record only (MCZ) 1; *Worcester Co.*: Southborough (USNM) 1.

Reported from this state by Harris (1833: 581, 1841: 104), Hartzell (1910: 497), Slingerland and Crosby (1914: 403), Isely (1920: 6), and Herrick (1925: 175) as "found from Massachusetts to Colorado".

**Michigan.** *Genesee Co.*: county record only (UMMZ) 1; *Gladwin Co.*: county record only (UMMZ) 1; *Huron Co.*: Port Crescent State Park (UMMZ) 1; *Ingham Co.*: county record only (UMMZ) 2, East Lansing (NDSU) 3, (East Lansing)/ Agriculture State College (as "Ag. Coll. Mich.") (CUIC) 1, (NDSU) 1, (USNM) 1; *Jackson Co.*: Waterloo State Recreation Area (UMMZ) 4; *Kalkaska Co.*: county record only (UMMZ) 1; *Livingston Co.*: E.S. George Reserve (UMMZ) 4; *Oakland Co.*: county record only (UMMZ) 5, Bloomfield (UMMZ) 2, Lake Orion (UMMZ) 1,



Milford (UMMZ) 1, Southfield (UMMZ) 2; *Washtenaw Co.*: county record only (UMMZ) 2, Ann Arbor (UMMZ) 6, Matthaei Botanical Gardens (UMMZ) 1, Salem Township (UMMZ) 1, Stony Creek (UMMZ) 1; *Wayne Co.*: Detroit (UMMZ) 1.

Reported from this state by Horn (1889: 220) as "Michigan to Florida", Hartzell (1910: 497) and Isely (1920: 6).

**(Minnesota)**. Reported from this state by Quaintance and Shear (1907: 24), Hartzell (1910: 497), and Isely (1920: 6), but not confirmed here by specimens examined.

Reported from this state by Quaintance and Shear (1921: 27).

**Missouri**. *Boone Co.*: Columbia (SMCC) 1, (USNM) 5; *Randolph Co.*: 1 mi. E Moberly (CUIC) 49.

Reported from this state by Riley (1870a: 309), Hartzell (1910: 497) and Isely (1920: 6).

**Mississippi**. *Desoto Co.*: Horn Island (CUIC) 6; *Harrison Co.*: Gulfport (USNM) 1; *Hinds Co.*: Jackson (NDSU) 1; *Lafayette Co.*: Oxford (NDSU) 1; *Lauderdale Co.*: Meridian (USNM) 2; *Oktibbeha Co.*: Agriculture College of Mississippi (CUIC) 1.

**(Nebraska)**. Reported from this state by McMillan (1888:74), Quaintance and Shear (1907: 24; 1921: 27), Hartzell (1910: 497) and Isely (1920: 6), but not confirmed here by specimens examined.

**New Hampshire**. *Rockingham Co.*: Hampton (UNHC) 1, Raymond (UNHC) 1, Seabrook (UNHC) 1; *Strafford Co.*: Durham (UNHC) 5; *Sullivan Co.*: Claremont (UNHC) 1.

New Jersey. State record only (USNM) 1; *Atlantic Co.*: Buena (MCZ) 3; *Cape May Co.*: Anglesea (USNM) 1; *Morris Co.*: Lake Hopatcong (as "Hopakong") FMNH) 1; *Ocean Co.*: Lakehurst (USNM) 1; *Orange Co.*: Greenwood Lake (USNM) 1; *Warren Co.*: Mountain Lake (FMNH) 1.

Not located: Crystal Lake (CUIC) 1 (county not specified, several possibilities).

Reported from this state by Smith (1890: 225; 1900: 312; 1910: 352), Hartzell (1910: 497) and Isely (1920: 6).

**(New Mexico)**. Reported from this state by Townsend (1891: 7), Hartzell (1910: 497), Slingerland and Crosby (1914: 403) and Isely (1920: 6).

Reported from this state by Herrick (1925: 175) as "south to Florida to New Mexico".

**New York**. State record only: (PURC) 1, (USNM) 1; *Allegany Co.*: Belmont (NDSU) 1; *Erie Co.*: Angola (USNM) 1; *Essex Co.*: Whiteface Mountain (EGRC) 3; *Franklin Co.*: Orient/ Long Island (as "L.I.") (CUIC) 2; *Genesee Co.*: county record only (USNM) 1, Batavia (USNM) 65; *Niagara Co.*: Olcott (CUIC) 8, (USNM) 2; *Orange Co.*: West Point (USNM) 4; *Queens Co.*: Long Island (as "LI")/ Rockaway Beach (USNM) 1; *Rockland Co.*: Bear Mountain (CUIC) 1, (USNM) 1; *Salem Co.*: Killcohook Wildlife Refuge (SMCC) 1; *Seneca Co.*: Willard (USNM) 1; *Suffolk Co.*: Long Island Aqueduct (as "Aqued't") (USNM) 1, Napeaque/ Long Island (as "LI") (CUIC) 1; *Tompkins Co.*: Ithaca (CUIC) 4, (FAMU) 1, (UCR) 2, (UNHC) 1, (WFBM) 2, (Cornell University) Campus (CUIC) 1, (USNM) 1, / Taughanick (CUIC) 4.

Reported from this state by Thomas (1834: 113) as *Chrysomela vitivora*, LeConte (1824: 173) as *Galleruca janthina*, Fitch (1859a [1856]: 84; 1859b: 171), Comstock (1880: 214), Lintner (1890: 188; 1891: 332, 353; 1893: 298), Lowe (1898: 263), Felt (1900a: 555, 563, 564, 570, 573; 1900b: 15; 1901: 1005; 1902: 838), Hartzell (1910: 497; 1924: 82), Reh (1913: 524), Slingerland and Crosby (1914: 403), Isely (1920: 6), Leonard (1928: 477) and Downie and Arnett (1996: 1374).

**North Carolina**. State record only (MCZ) 4, (USNM) 1; *Buncombe Co.*: Asheville (USNM) 1; *Douglas Co.*: county record only (SEM) 1; *Guilford Co.*: (Greensboro) North Carolina Agricultural and Technical State University (as "NC Dept. Agr. Entomological Cat. No. 282") (UCR) 1; *Haywood Co.*: Hazelwood/ Little Mountain (as "Lt.Mtn") (USNM) 1; *Jackson Co.*: Balsam (USNM) 2; *Nash*



*Co.*: Rocky Mount (UCR) 1; *Pitt Co.*: Greenville (SEM) 1; *Swain Co.*: Indian Gap (USNM) 1; *Union Co.*: county record only (NDSU) 2; *Wake Co.*: Raleigh (UCR) 1, 3 mi. N. Wake Forest (USNM) 1.

Reported from this state by Hartzell (1910: 497), Isely (1920: 6), Brimley (1938: 228) and Downie and Arnett (1996: 1374).

**Ohio.** *Butler Co.*: Oxford (CUIC) 2; *Delaware Co.*: at junction Deer Run and Scioto River (SMCC) 1, O'Shaughnessy Reservoir (SMCC) 3; *Franklin Co.*: Columbus (SMCC) 3, (WFBM) 1, / Ohio State University Campus (SMCC) 2, / near Mason Run (SMCC) 1, Mifflin Township near Mock Park (SMCC) 1; *Hocking Co.*: county record only (SMCC) 1, Ash Cave (SMCC) 1; *Montgomery Co.*: Wayne Township (SMCC) 1; *Richland Co.*: Mansfield (SMCC) 2; *Ross Co.*: Chillcothe/ 1 mi. S route 50 at Scioto River (SMCC) 1, Tar Hollow State Forest (SMCC) 2; *Vinton Co.*: Lake Hope (SMCC) 1, Lake Hope State Park (SMCC) 3; *Washington Co.*: Hune Bridge/ 2.5 mi. N Dart (SMCC) 2.

Reported from this state by Hartzell (1910: 497), Isely (1920: 6), Wilcox (1954: 446) and Forsythe and Still (1969: 33).

**Oklahoma.** *Murray Co.*: 2 mi. S Sulphur (USNM) 1.

Reported from this state by Hatch and Ortenburger (1926: 10).

**Pennsylvania.** State record only: (USNM) 1; *Allegheny Co.*: county record only (CUIC) 6; Pittsburgh (UMMZ) 1; *Beaver Co.*: Brighton (USNM) 1; *Centre Co.*: First Mountain (as "1st Mt.") (NDSU) 1, State College (USNM) 1; *Chester Co.*: county record only (USNM) 1; *Cumberland Co.*: Camp Hill (as "Camphill") (UMMZ) 2, Enola (UMMZ) 2; *Delaware Co.*: county record only (FMNH) 2; *Erie Co.*: North East (USNM) 1, Presque Isle State Park (CUIC) 17; *Monroe Co.*: county record only (USNM) 3; *Montgomery Co.*: Abington (MCZ) 1, Glenside (USNM) 1, Edge Hill (USNM) 1; *Northumberland Co.*: Elysburg (USNM) 1; *Philadelphia Co.*: Philadelphia (as "Phila.") (USNM) 11; *Pike Co.*: Camp Colang (FMNH) 1; *Washington Co.*: Canonsburg/ Mount Blain (UMMZ) 1; *York Co.*: Frogtown (NDSU) 1.

Reported from this state by Melsheimer (1806: 22) as *Altica oleracea*, Thomas (1834: 113) *sub Chrysomela vitivora*, Comstock (1880: 214, 215), Hartzell (1910: 497), Isely (1920: 6), Eyer and McCubbin (1926), Downie and Arnett (1996: 1374) and LeSage (2000: 233).

**Rhode Island.** *Kent Co.*: Warwick (UMMZ) 5.

**South Carolina.** *Charleston Co.*: Island of Palms (MCZ) 1; *Florence Co.*: Florence (NDSU) 1; *Greenville Co.*: Greenville (TAMU) 1; *Horry Co.*: Myrtle Beach (NDSU) 7, (USNM) 2.

Reported from this state by Hamilton (1895: 340), Kirk (1969: 96; 1970: 92) and Downie and Arnett (1996: 1374).

**Tennessee.** *Coche Co.*: 6 mi. SE Cosby (UNHC) 1; *Davidson Co.*: Nashville (USNM) 1; *Elkhart Co.*: Dunlap (LEM) 1; *Sevier Co.*: Gatlinburg (MZELU) 1.

**Texas.** State record only: (MCZ) 2, (USNM) 1; *Jefferson Co.*: Sabine Pass (SMCC) 2; *Lavaca Co.*: 10 mi. N Hallettsville (TAMU) 1; *Webb Co.*: county record only (UMMZ) 1.

Not located: Brighton (USNM) 1.

Reported from this state by Horn (1889: 220), Hartzell (1910: 497), Quaintance and Shear (1907: 24; 1921: 26), Isely (1920: 6), Wilcox (1975: 110) and Downie and Arnett (1996: 1373).

**Utah.** *San Juan Co.*: Monument Valley (USNM) 1.

**(Vermont).** Reported from this state by Hartzell (1910: 497), and Isely (1920: 6) but not confirmed here by specimens examined.

**Virginia.** State record only: (USNM) 1; *Arlington Co.*: Glencarlyn (USNM) 1; *Chesapeake Co.*: Lake Drummond (USNM) 4; *Fairfax Co.*: county record only (USNM) 1, Dawson Beach 4 mi. S of Occoquan (USNM) 1, Falls Church (USNM) 3, Vienna (USNM) 1; *Fauquier Co.*: Warrenton (USNM) 1; *Giles Co.*: Jefferson National Forest (USNM) 5; *Hampton Co.*: Fort Monroe (Station)



(USNM) 1; *Lee Co.*: Pennington Gap (MCZ) 2, (USNM) 1; *Nelson Co.*: county record only (USNM) 1; *Shenandoah Co.*: Woodstock (USNM) 1; *Virginia Beach City*: Cape Henry (USNM) 5, Virginia Beach (as "Princess Anne Co.") (USNM) 1; *Westmoreland Co.*: Colonial Beach (USNM) 1.

Reported from this state by Comstock (1880: 215), Isely (1920: 6) and Downie and Arnett (1996: 1374).

**West Virginia.** *Barbour Co.*: Audra State Park (SMCC) 1; *Berkeley Co.*: county record only (SMCC) 6, Boyds Gap/ North Mountain (SMCC) 1, Potomac Park (SMCC) 1; *Braxton Co.*: Left Fork (of) Holly River near Holly (SMCC) 2; *Cabell Co.*: Green Bottom Wildlife Management Area (SMCC) 1, Huntington (SMCC) 1; *Doddridge Co.*: New Milton (SMCC) 1, 3 mi. E Sherwood (SMCC) 1, Smithburg (SMCC) 1; *Fayette Co.*: Fayette Station (SMCC) 1, Hawks Nest State Park (SMCC) 1, McKendree (SMCC) 1, New River Gorge near Prince (SMCC) 1; *Gilmer Co.*: Cedar Creek State Park (SMCC) 14, Stouts Mills (SMCC) 1, Tumbling Run (SMCC) 1; *Grant Co.*: North Fork of Patterson Creek at Greenland Gap (SMCC) 1; *Hardy Co.*: Old Fields (SMCC) 1; *Harrison Co.*: Clarksburg (SMCC) 1, Dog Run Nature Preserve/ near Salem (SMCC) 3; *Jackson Co.*: Ripley (SMCC) 4, 1 mi. N Ripley Landing (SMCC) 1; *Jefferson Co.*: Shepherdstown (SMCC) 1; *Kanawha Co.*: Guthrie (SMCC) 66, (WVDA) 3, / headwaters of Fisher Branch near Guthrie (SMCC) 1, / 0.5 mi. S Sixmile Branch Kanawha State Forest (SMCC) 12, (WVDA) 2, Lens Creek (SMCC) 2, Sissonville/ Tupper Creek at Spencer Branch (SMCC) 1; *Lewis Co.*: Jane Lew (SMCC) 1; *Lincoln Co.*: Hilbert Public Hunting Area (SMCC) 1; *Marshall Co.*: Glendale (SMCC) 2, Moundsville (SMCC) 2, Mount Olivet (SMCC) 1; *Mason Co.*: Beech Hill (SMCC) 9; *Mineral Co.*: Barnum (SMCC) 1, Keyser (SMCC) 1; *Monongalia Co.*: Blacksville (SMCC) 1, Cheat Neck (SMCC) 1, Core (SMCC) 3, Morgantown (SMCC) 2, / 3.5 mi. NE (SMCC) 1, Stewartstown (SMCC) 1; *Monroe Co.*: 1 mi. W Red Hill (SMCC) 5; *Morgan Co.*: Middle Fork (of) Indian Run (at) Cacapon State Park, (SMCC) 1, 2 mi. SE Hancock (SMCC) 1; *Nicholas Co.*: Gauley River near Peters Junction (SMCC) 1; *Ohio Co.*: 1 mi. SW Clinton (SMCC) 2; *Pendleton Co.*: Judy Gap (SMCC) 1, 1 mi. NW Ruddle (SMCC) 1, 3 mi. NW Ruddle (SMCC) 5, 5 mi. NW Ruddle (SMCC) 4; *Pleasants Co.*: Arvilla (SMCC) 1, Willow Island (SMCC) 1; *Pocahontas Co.*: Marlinton (SMCC) 1; *Preston Co.*: Cranesville Swamp (SMCC) 1; *Putnam Co.*: Hurricane (SMCC) 1, Teays (SMCC) 1; *Raleigh Co.*: Sandstone Falls (in) New River (SMCC) 1; *Roane Co.*: Stutler Run 1.5 mi. N Reedy (SMCC) 3; *Summers Co.*: Sandstone (SMCC) 1; *Taylor Co.*: Grafton (SMCC) 2, Valley Falls State Park (SMCC) 1; *Tyler Co.*: Luzon (SMCC) 1; *Upshur Co.*: 3 mi. E Buckhannon (SMCC) 8; *Wayne Co.*: Shoals (SMCC) 2; *Wetzel Co.*: Anthem (SMCC) 1, Newdale (SMCC) 2, Peabody (SMCC) 5, Pine Grove (SMCC) 1, Vernon (SMCC) 1; *Wirt Co.*: Stutler Run/ 2 mi. S (of) Lucile (SMCC) 1.

Not located: "Eng./ T.Z." (USNM) 1.

Reported from this state by Isely (1920: 6) and Clark (2000: 32).

**Wisconsin.** *Racine co.*: Kilbournville (as "Kilbourn") (USNM) 1.

Reported from this state by Isely (1920: 6).

**Distribution.** The distribution of *Altica chalybea* extends from southern Ontario and Québec to Florida and Texas with a western extension into Colorado (Figure 7). Rhode Island, Kentucky, Tennessee, Mississippi, and Louisiana are new state records. The presence of *Altica chalybea* on Guadeloupe Island (California), and Utah, corresponds to an introduction since no native species of *Vitis* or *Parthenocissus* grow naturally there (Gleason 1963: 517-520).

The literature records from Maine, Vermont, Arkansas, Minnesota, Nebraska and New Mexico have not been corroborated during the course of this study but fit well into the known distribution of the species.



**Host-plants.** The following host-plants, mentioned in the literature for *Altica chalybea*, are considered here either as “true” host-plants when beetles can complete their development on these plants, or “accidental” when the plants were misidentified, the beetles accidentally occurred on these plants, or the errors came from misidentifications of the flea beetles.

a) true host-plants mentioned in the literature:

- Wild grape: see *Vitis* spp.
- Bunch grapes (= either the European *Vitis vitifera* L. or the American *Vitis labrusca* L.): Kirk (1970: 92).
- *Clinton* (= a variety of *Vitis riparia* Michx. fide Engelmann (1869: 321)): as “a vineyard of *Clinton* grape which was totally devastated” reported by Slingerland (1898: 194).
- *Concord* (= variety of *Vitis labrusca* L. fide Engelmann (1869: 321)): as “attacked the *Concord* grape more than any other” by Fletcher (1884: 7), cited by Slingerland (1898: 194); as “the Concord, Salem, Martha and Brighton vines” by Fletcher (1885: 26); as “the only food plants found during five seasons have been the *Concord* grape” by Hartzell (1915: 203); as “prefer the *Concord* during the spring” by Hartzell (1915: 203); as “does not favour thick-leaved sorts like the *Concord*” by Isely (1920: 4).
- Cultivated grape (= *Vitis vitifera* L., variety not specified): Saunders (1871: 108; 1883: 279; 1885: 17; 1889: 279; 1900: 279); Gott (1878: 45; 1879: 58); Slingerland (1898: 194); Lintner (1890: 188; 1891: 332, 353); “as young larvae... on grape” by Lintner (1893: 298); Bethune (1893: 10; 1898: 33); Lowe (1898: 263); Felt (1902: 838); Thomas (1906: 197); Hartzell (1910: 497; 1924: 82); Gibson (1913: 6); Reh (1913: 524); Isely (1920: 4); Quaintance and Shear (1907: 23; 1921: 27); Britton (1926: 221); Ross (1926a: 30; 1926b: 188); Caesar (1927: 44); Eyer and McCubbin (1926: 12); Zappe (1928: 729; 1930: 609).
- *Delaware* (= variety of *Vitis riparia* Michx. fide Engelmann (1869: 321)): as “the larvae flourishes on thin-leaved varieties like the Delaware” (Isely 1920: 4).
- Muscadine (= *Vitis vulpina* L. fide Engelmann (1869: 321)); Balsbaugh and Hays (1972: 148). See below.
- *Parthenocissus quinquefolia* (L.) Planch. (Virginia Creeper): Bethune (1893: 10), and Bethune (1898: 33) as *Ampelopsis quinquefolia*; Lugger (1899: 243) as *Ampelopsis quinquefolia*; Saunders (1883: 279; 1889: 279; 1900: 279) as *Ampelopsis quinquefolia*; Thomas (1906: 197); Reh (1913: 524); Isely (1920: 4) as *Pseuderia quinquefolia*; Quaintance and Shear (1921: 27); Herrick (1925: 175); Caesar (1927: 44); Gibson (1928: 26; 1934a: 30; 1934b: 32); Zappe (1930: 609); Blunck (1954: 325), Campbell *et al.* (1989: 68).
- Virginia Creeper: see *Parthenocissus quinquefolia*.
- *Vitis* sp.: (Thomas 1834: 113) [as *Chrysomela vitivora*]; as “wild and cultivated grapes” by Harris (1841: 104; 1842: 104; 1852: 114; 1862: 129); Riley (1870b: 327); Saunders (1883: 279; 1889: 279; 1900: 279); as “commonly confined to grape vines, wild or cultivated” by McMillan (1888: 75); Bethune (1893: 10); Marlatt (1896: 396); Lugger (1899: 241); Bethune (1907: 35); Quaintance and Shear (1907: 24; 1921: 27); Blatchley (1910: 1201); Slingerland and Crosby (1914: 403); as “the chief food plants of the grape-vine flea-beetle are the various species of wild and cultivated grapes found in the eastern United States” by Hartzell (1915: 202); Blatchley (1924: 20); as “destroy all wild grapevines” by Hartzell (1924: 83); as “destroying all wild grape vines” by Ross (1926a: 30); Caesar (1927: 44); Britton (1928: 675); Zappe (1928: 729; 1930: 609); Blunck (1954: 325); Kirk (1969: 96; 1970: 92); Borror *et al.* (1989: 460); as “wild grapes” by Dearborn and Donahue (1993: 67); Downie and Arnett (1996: 1374).
- *Vitis bicolor* LeConte (Wild Blue Grape): as “this grape species has been the preferred host during five years” according to Hartzell (1915: 203). Quoted later by Isely (1920: 4).



- *Vitis labrusca* L.: Clark (2000: 33).
- *Vitis rotundifolia* Michx.: Balsbaugh and Hays (1972: 148); Wilcox (1979: 25).
- *Vitis vulpina* L. (= Muscadine): Clark (2000: 33).
- *Vitis vinifera* L. : Fitch (1859a [1856]: 69, 84) as "*Vitis vinifera et. al*".

b) accidental host-plants mentioned in the literature:

- *Acer saccharum* Marsh. (Sugar Maple): no feeding observed by Hartzell (1915: 203).
- Alder: see *Alnus*.
- *Alnus serrulata* (Ait.) Winkler (Rough Alder) [now considered a variety of *Alnus rugosa* (Du Roi) Spreng.] by Scoggan (1978: 589); Saunders (1883: 279; 1889: 279; 1900: 279); Schwarz (1892: 183); Lugger (1899: 243). In my opinion, all these records are in error and refer to the host-plant of *Altica ambiens alni* Harris (LeSage 1995).
- *Alnus* sp. (Alder): Fitch (1859a [1856]: 84); Marlatt (1896: 396); Reh (1913: 524).
- American Elm: see *Ulmus americana*.
- Apple: see *Malus pumila*.
- Ash (White Ash): see *Fraxinus americana*.
- *Betula lenta* L. (Cherry Birch): no feeding observed by Hartzell (1915: 203).
- Birch (Cherry Birch): see *Betula lenta*.
- Black Alder (= *Alnus glutinosa* (L.) Gaertn. [a European plant spread from cultivation and locally naturalized *fide* Scoggan (1978: 588)]: Harris (1835: 54), cited by Isely (1920: 4).
- Black Raspberry: see *Rubus* spp.
- Blue or Water Beech (= *Carpinus* sp.): Schwarz (1892: 183). Cited later by Quaintance and Shear (1907: 24; 1921: 27), Hartzell (1910: 498), and Isely (1920: 4).
- Canadian Elder: see *Sambucus canadensis*.
- *Carpinus* sp.: only adults found great numbers on this plant *fide* Schwarz (1892: 183), Reh (1913: 524)+.
- Cherry Birch: see *Betula lenta*.
- Common Chickweed: see *Stellaria media*.
- Common Willow: see *Salix alba*.
- *Cornus stolonifera* Michx. (Red Osier): no feeding observed by Hartzell (1915: 203).
- *Crataegus* sp.: no feeding observed by Hartzell (1915: 203).
- *Cydonia oblonga* Mill. (Quince): as "seedlings of ..." by McMillan (1888: 75), cited later by Quaintance and Shear (1907: 24; 1921: 27), Hartzell (1910: 498), and Isely (1920: 4).
- Dandelion: see *Taraxacum officinale*.
- Dog's Tooth Violet: see *Erythronium americanum*.
- Elder: see *Sambucus canadensis*.
- Elm: see *Ulmus* sp.
- *Erythronium americanum* Ker-Gawl. (Dog's Tooth Violet): no feeding observed by Hartzell (1915: 203).
- *Fagus grandifolia* Ehrh. (American Beech): no feeding observed by Hartzell (1915: 203).
- *Fragaria* sp. (Strawberry): no feeding observed by Hartzell (1915: 203).
- *Fraxinus americana* L. (White Ash or Ash): no feeding observed by Hartzell (1915: 203).
- Hawthorn: see *Crataegus* sp.
- *Malus pumila* Mill. [*Pyrus* (*Malus*) *sylvestris* L. is synonym *fide* P. Catling (pers. comm.)] (Apple): McMillan (1888: 75). Quoted later by Quaintance and Shear (1907: 24; 1921: 27), Hartzell (1910: 478), Isely (1920: 4), and Dean (1930: 140). No feeding observed by Hartzell (1915: 203).
- *Mucuna deeringania* (Bot.) Mer. Blatchley (1924: 20).
- *Myrica* sp.: Blatchley (1924: 20).



- Peach: see *Prunus persica*.
  - Pear: see *Pyrus communis*.
  - Plum, Plum tree: see *Prunus domestica*
  - Poison Ivy: see *Rhus radicans*.
  - *Prunus domestica* L. (Plum, Plum tree): Fitch (1859a [1856]: 84); "sometimes feeds on", Saunders (1883: 190, 279; 1889: 190, 279; 1900: 190, 279); Britton (1898: 316); Lugger (1899: 243); McMillan (1888: 75); Quaintance and Shear (1907: 24; 1921: 27); Isely (1920: 4); as "on plum blossoms" Blatchley (1924: 20); Dean (1930: 140). No feeding observed by Hartzell (1915: 203).
  - *Prunus* sp.: doubtful occurrence *fide* Schwarz (1892: 183).
  - *Prunus persica* L. (Peach): as "seedlings of ..." by McMillan (1888: 75); Neal (1890: 11), cited by Isely (1920: 4), Quaintance and Shear (1907: 24; 1921: 27). No feeding observed by Hartzell (1915: 203).
  - *Pyrus communis* L. (Pear): no feeding observed by Hartzell (1915: 203).
  - *Cydonia oblonga* Mill. (Quince): as "seedlings of ..." by McMillan (1888: 75), cited later by Quaintance and Shear (1907: 24; 1921: 27), Hartzell (1910: 498), and Isely (1920: 4).
  - Quince: see *Cydonia oblonga* Mill.
  - Red Osier: see *Cornus stolonifera*.
  - Red raspberry: see *Rubus* spp.
  - *Rhus radicans* L. (Poison Ivy): Blatchley (1910: 1201). No feeding observed by Hartzell (1915: 203).
  - *Rhus typhina* L. (Sumac): no feeding observed by Hartzell (1915: 203).
  - *Rubus* spp. (Black and Red Raspberry): no feeding observed by Hartzell (1915: 203).
  - *Salix alba* L. (Common Willow): no feeding observed by Hartzell (1915: 203).
  - *Sambucus canadensis* L. (Elder, Canadian Elder): no feeding observed by Hartzell (1915: 203).
  - *Stellaria media* (L.) Cyrill. (Common Chickweed): no feeding observed by Hartzell (1915: 203).
  - Strawberry: see *Fragaria* sp.
  - Sugar Maple: see *Acer saccharum*.
  - Sumac: see *Rhus typhina*.
  - *Taraxacum officinale* Weber (Dandelion): no feeding observed by Hartzell (1915: 203).
  - *Ulmus* sp. (Elm): Fitch (1859a [1856]: 84; 1859a [1858]: 63); Reh (1913: 524), Dean (1930: 140). Doubtful occurrence *fide* Schwarz (1892: 183), Quaintance and Shear (1907: 24), and Isely (1920: 4). No feeding observed by Hartzell (1915: 203).
  - *Ulmus americana* L. (American Elm): no feeding observed by Hartzell (1915: 203).
  - Velvet bean: see *Mucuna deeringiana* (Bot.) Mer.
  - Wax myrtle: see *Myrica* sp.
  - White Ash: see *Fraxinus americana*.
  - Willow (Common Willow): see *Salix alba*.
- c) true-host plants recorded on the labels of specimens examined:
- Concord grape (= a cultivated variety of *Vitis labrusca* L.; 1 record.
  - Cultivated Grape: see *Vitis vitifera*.
  - Grape: see *Vitis* sp.
  - Muscadine Grape (*Vitis vulpina* L.): 1 record
  - *Vitis* spp. 20 records.
  - *Vitis riparia* Michx., or Wild Grape: 4 records.



- *Vitis rotundifolia* Michx.: 1 record.
- *Vitis vitifera* L. (variety not specified): 2 records.

d) accidental host-plants recorded on the labels of specimens examined:

- *Amelanchier* sp.: 1 record.
- *Barbarea vulgaris* R. Br. (flowers of): 1 record.
- *Cornus stolonifera* Michx. (beating of): 1 record.
- *Crataegus* sp. : 1 record.
- Goldenrod (*Solidago* sp.): 1 record.
- Hawthorn (*Crataegus* sp.): see above.
- Oak (*Quercus* sp.): 1 record.
- Pine tree (*Pinus* sp.): 1 record.
- *Populus tremuloides* Michx. (beating of): 1 record.
- Spanish moss (*Tillandsia usneoides*): 1 record.
- "Wild thorn" (stem of; *Crataegus* sp.): 1 record

**Biology.** Like the majority of *Altica* species, *A. chalybea* overwinters in the adult stage. The first cold temperatures of the fall trigger adults to search for suitable places to overwinter with preference for woods and wastelands around vineyards (Hartzell 1910; Slingerland and Crosby 1914; Weigle and Kovach 1995). Various shelters are utilized: crevices of the bark and in the earth immediately around the root of the tree on which it feeds (Fitch (1859*b*), loose bark or crevices of stakes (Riley 1870*a*), in any crevices under stones, sticks or logs (Comstock 1880), in cracks of fences or buildings, in masses of leaves or under bark (Harrington 1882*b*; Marlatt 1896), around roots of vines (Comstock 1880; Lugger 1899), under bark and rubbish (Blatchley 1910), mainly under dry leaves and rubbish in woodlands, also under bark of trees or vines (Hartzell 1910), under loose bark, and trash around vineyards (Slingerland and Crosby 1914), under leaves, grass and rubbish (Ross and Armstrong 1949), and under plant debris (McGrew and Still 1979; Campbell *et al.* 1989).

Overwintered adults emerge in early spring in synchrony with the appearance of the first buds on vine canes and move from their winter quarters into vineyards (McGrew and Still 1979). In the Ottawa area, this migration corresponds to the last week of April or first week of May. It occurs earlier at lower latitudes.

Emerging males and females feed on buds for 1-2 weeks before mating and ovipositing. Blatchley (1910) observed first matings in Indiana on April 12. Pairs are rarely seen before the second week of May in the Ottawa area but were seen as soon as mid-April in spring 2002, during exceptionally warm days (25°C). According to Hartzell (1910) and my own observations, the mating period lasts over a month, until the death of the spring adults. Repeated copulations are usual in rearing cages, and probably occur in nature as well (Hartzell 1910). Spring adults eat the tender parts of developing buds, boring holes into them (Figure 8), or even scooping them out completely (Hartzell 1910; Still and Rings 1973; McGrew and Still 1979; Taschenberg and Riedl 1985; Weigle and Kovach 1995). After the buds have opened, they chew small holes in the leaves.

Oviposition begins a few days after mating. Eggs are usually deposited on buds, under bud scales (Isely 1920; Quaintance and Shear 1907), and within spaces in cracks of the bark at the base of the buds (Gibson 1913) or under loose bark of canes. Saunders (1883; 1889; 1900) reported that eggs are laid on the underside of the young vine leaves. Such questionable observations probably concerned the oviposition of *Altica woodsi*. For instance, Slingerland and Crosby (1914) claimed that eggs were rarely laid on leaves, whereas Marlatt (1896), and Lugger (1899) mentioned that eggs were occasionally laid there. According to Isely (1920), citing Comstock (1880), they are laid





FIGURE 8. Unopened grapevine buds damaged by adults of *Altica chalybea* in early spring.

on both sides of leaves, whereas Peairs (1941) reported that eggs were laid on almost any part of the vines.

Females of *Altica chalybea* lay eggs singly or in small irregular clumps of 4-5 (Riley 1870*b*; Comstock 1880), in cracks in the bark at base of buds, between bud scales, or even in the holes which have been eaten into the buds (Quaintance and Shear 1921). The length of the eggs ranges from 0.93 to 1.14 mm with an average of 1.03 mm (Hartzell 1910). Their colour varies from straw (Comstock 1880, Isely 1920; Slingerland and Crosby 1914), to deep yellow (Isely 1920), or orange (Marlatt 1896; Lugger 1899; Isely 1920). The number of eggs laid by females is quite variable. According to Hartzell (1910), an average of 70 eggs were laid by females during their lives, with a maximum of 210 observed. This author also mentioned that the greatest numbers of eggs were laid during the warmest part of the day. The incubation period is highly dependent on weather conditions. It averaged 15 days and extended from May 18 to June 28 in eggs obtained from adults maintained in cages by Isely (1920). The oviposition period lasts roughly 2 months, from April to early June, with more or less important variations according to local weather conditions and latitude. First instar larvae can be seen as early as mid-March in Georgia according to Comstock (1880). There are 3 larval instars in *Altica chalybea*. Each instar lasts about 8 days, for a total larval period of 3-4 weeks (Isely 1920).

Larvae are exclusively leaf feeders. According to authors, the larvae are supposed to feed only the upper surface of the leaves and produce typical chain-like white patches on the leaf blade, but those reared in Petri dishes in 2002 fed exclusively on the undersurface of leaves. Larger larvae riddle the leaves with large irregular holes and can completely skeletonize the leaves (Comstock 1880, Neal 1890) if they are numerous. In the Northeast, larvae are mainly found on the vines in June and July (Isely 1920).

When fully grown, larvae drop onto the ground to pupate. Pupation takes place one to several inches underground in small earthen cells made of packed soil particles. The colour of the pupa varies from yellow (Hartzell 1910) to dark yellowish (Lugger 1899), saffron-yellow (Slingerland and Crosby 1914) or yellowish brown (Comstock 1880). The period of time spent underground lasts two to three weeks, and occurs largely in late June and July in the Northeast (Comstock 1880; Marlatt 1896; Isely 1920).

New adults appear on vines in late July. I agree with Lugger (1899), and Hartzell (1910) that these adults feed little on leaves in contrast to Comstock (1880) who reported that they do



considerable damage to leaves. According to Riley (1870b), Isely (1920), and my own observations, new adults do not mate nor oviposit but remain active on plants until the end of summer.

There is only one generation per year in the Northeast (Hartzell 1924; Eyer and McCubbin 1926). Marlatt (1896) and Comstock (1880) reported that there might be two in southern states, but their hypothesis has not yet been confirmed.

**Parasites.** Although none were found by Riley (1870b), Comstock (1880), or Isely (1920), parasites of adults or larvae probably exist but have not yet been identified.

**Predators.** Isely (1920) claimed that adults of *Altica chalybea* were found in the stomach contents of several kinds of birds. In my opinion, this statement is in error for two reasons. Firstly, *A. chalybea* adults are unlikely to be caught by birds due to their jumping habits, and secondly, they cannot be identified from body fragments.

Lintner (1891), cited later by Slingerland (1898), reported that Mr. George C. Snow of Penn Yan, New York observed a nymph of a stink bug, identified later by Mr. Uhler as probably *Podisus modestus* Dallas, sucking out the juices of a grape flea-beetle larva. Slingerland (1898) also observed the lady-bird *Megilla maculata* (= *Coleomegilla maculata lengi* Timberlake) "eating a young grub of the grape-vine flea-beetle", but concluded that these predators have done little to hold the grape flea beetle in check.

Hartzell (1915) noticed that eggs were not attacked by parasites to any extent. The larvae, however, were preyed upon by a species of carabid which closely resembles the adult flea-beetle in size and colour (probably *Lebia* sp.). These beetles were not found in high numbers, so their activities did not decrease the number of larvae to any great extent. In Aylmer, Québec (north of Ottawa, Ontario), I collected adults of the carabids *Lebia moesta* LeConte and *L. viridis* Say along a fence where *Altica chalybea* was breeding.

Hartzell (1915) also reported a nymph of an undetermined species of Pentatomidae piercing the bodies of the larvae and sucking their body fluids. Finally, the adults did not appear to be fed upon by birds.

In rearing cages, the ground beetle *Harpalus erythropus* Dejean fed on the larvae and pupae of *A. chalybea*, whereas *Lebia viridis* Say and *L. ornata* Say attacked its eggs, larvae, and pupae (Isely 1920). Isely also mentioned that the ant *Myrmica scabrinodis* Nylander destroyed larvae and pupae of this flea beetle under rearing conditions.

**Common names.** Harris (1841: 104, 1842: 104, 1852: 129, 1862: 129) first popularized the names "*Steel-blue flea-beetle*" for its usual blue colour and "*Grape-vine flea beetle*" in reference to its host-plant. Riley (1868: 27; 1870b: 327) also used both, whereas the latter name has been adopted by Harris (1854: 11), Fitch (1859a [1856]: 84), Saunders (1871: 108; 1872: 359; 1883: 277; 1884: 207; 1885: 17; 1889: 277; 1900: 277), Gott (1878: 45; 1879: 58), Harrington (1882a: 25; 1882b: 60), Smith (1890: 225), Lintner (1891: 332, 353), Bethune (1893: 10; 1898: 33; 1907: 35), Marlatt (1896: 395), Lowe (1898: 263), Lugger (1899: 241), Felt (1900a: 555, 563, 564, 601; 1900b: 15; 1901: 1005; 1902: 838), Thomas (1906: 197), Caesar (1914: 81; 1916: 31), Gibson (1914: 27), Quaintance and Shear (1922: 239), Herrick (1925: 175), Ross and Caesar (1925: 86), Britton (1926: 221; 1928: 675), Caesar and Ross (1925: 86; 1926: 14), Ross (1926a: 30; 1926b: 188), Caesar (1927: 44), Leonard (1928: 477) and Zappe (1928: 729; 1930: 609).

The shorter form "*Grape flea beetle*" was first proposed by Smith (1900: 312; 1910: 352) and accepted later by the *Entomological Society of America*: Muesebeck (1942: 87, 93), Werner (1982: 19), Stoetzel (1989: 29), Bosik (1997: 31), and most authors of the last century: Blatchley (1910: 1201), Hartzell (1910: 494), Smith (1910: 352), Eyer and McCubbin (1926: 12), Gibson (1934a:



32), MacNay (1955: 80), Balsbaugh and Hays (1972: 148), Benoit (1975: 25; 1985: 10), Taschenberg and Riedl (1985: 1), Dearborn and Donahue (1993: 67), Weigle and Kovach (1995: 8), Clark (2000: 32).

“*Steel-blue beetle*” was utilized once by Riley (1870a: 309), and later changed to “*Steel-blue flea-beetle*” (Riley 1889: 221). “*Steely beetle*” is given as a variation by Hartzell (1910: 494; 1924: 82). Finally, Riley (1870b) reported that some vineyardists erroneously called the grape flea beetles “thrips” when they first noticed them.

The popular name “*Steel-blue grapevine flea beetle*” has been erroneously used by Ebeling (1959: 333) for *Altica torquata* LeConte, a Southwestern species to be treated later in a separate contribution.

The French equivalent of the “*Grape flea beetle*”, is “*Altise de la vigne*” (SPPQ 1947: 8, 1952: 8, 1964: 9; Benoit 1975: 26, 1985: 10; Belton and Eidt 1996: 4).

**Economic importance and control.** The most important losses result through direct bud feeding by the overwintered adults when they hollow out the buds in the spring just as they are swelling (Gott 1879; Lintner 1891: 332, 353; Harrington 1882a,b; Saunders 1883, 1884, 1889, 1900; Hartzell 1924; Herrick 1925; Britton 1926, 1928; Eyer and McCubbin 1926; Ross 1926a, 1926b; Caesar 1927; Zappe 1930; Still and Rings 1973; McGrew and Still 1979; Weigle and Kovach 1995). Damage to buds largely occurs on vines located along the borders of vineyards next to wooded or trashy areas. Destroyed or damaged buds cannot develop into primary grape canes, and thus the crop yield is more or less reduced according to the severity of the attack.

Control measures are efficient only if they are timed with the vine development. Losses will be considerably reduced if the spring adults are killed before they chew up the developing buds. Weigle and Kovach (1995) recommended treatment as soon as damage to buds reached 1-2%.

Treatments applied in the past consisted mostly of arsenical poison (Marlatt 1896; Quaintance and Shear 1907; Slingerland and Crosby 1914). Air-slaked lime, Paris green, Bordeaux mixture, or unleached ashes were also tried with variable success (Lugger 1899; Quaintance and Shear 1907). Peairs (1941) suggested controlling the larvae before they produce new adults because it is too difficult to spray against the adults in the spring. Modern pesticides, such as *Rotenone*, *Malathion*, *Cygon*, etc. are probably more efficient than the old treatments, but accurate information on their efficiency is still lacking.

The grape flea beetle can also be partially controlled by appropriate vineyard management. The suggestion of Lugger (1899) to remove and destroy all rubbish that provides hibernation sites for adults is still valid. Hartzell (1910) also recommended keeping the vineyards clean and the surrounding wastelands clear.

## 2. *Altica woodsi* Isely, 1920

*Altica woodsi* Isely 1920: 11 (original description); Gibson 1925: 23 (biology in Ontario); Blackwelder 1939: 63 (supplement to the catalogue of North American Coleoptera); Heikertinger and Csiki 1940: 242 (world catalogue); Peairs 1941: 323 (handbook on insect pests); Wilcox 1954: 446 (Ohio fauna); MacNay 1956: 116 (infestation in Manitoba); Chagnon and Robert 1962: 316, 408 (Québec fauna); Balsbaugh and Hays 1972: 148 (Alabama fauna); Wilcox 1975: 110 (catalogue of North American Chrysomelidae); Wilcox 1979: 25 (host-plants of North American Chrysomelidae); Campbell *et al.* 1989: 74 (beetle pests of crops in Canada); Laplante *et al.* 1991: 99 (checklist of Québec Coleoptera); Downie and Arnett 1996: 1374 (Northeast fauna); Clark 2000: 34 (annotated list of West Virginia Chrysomelidae); Lasnier *et al.* 2001:4 (web site on Québec grape pests).



*Haltica woodsi* Isely, Leonard 1928: 477 (New York insect list); Chagnon 1938: 163 (Québec fauna); Chagnon 1940: 316 (Québec fauna); Blunck 1954: 326 (handbook of phytophagous beetles); Chagnon and Robert 1962: 316, 408 (Québec fauna).

*Haltica ignita* Lugger 1899: 243 [not *ignita* Illiger, 1807] (Minnesota insect pests). Misidentification.

*Haltica ignita* Gibson 1913: 7 [not *ignita* Illiger, 1807] (garden pests). Misidentification.

*Haltica (Altica) woodsi*, Gibson 1926: 578 (occurrence in Canada).

"An enemy to the grape", Worden 1862: 350 (report on infestation).

"The blue grape beetle", Larrowe 1862: 382 (answer to grower).

"Lesser grape vine flea-beetle", Fall 1920: 105 (taxonomic comments).

**Etymology.** Named in honour of W.C. Woods, an American entomologist who made important contributions to the biology and taxonomy of *Altica*.

**Diagnosis.** Elongate, small blue-green species, 3.3-3.8 mm long, with deep pronotal groove (Figure 1b). Male with tip of aedeagus triangular and weakly nipple-shaped in the middle, with ventral median carina and ventral longitudinal ridges, both well developed (Figure 2b). Female with styli narrow, and their inner margins weakly diverging at apex (Figure 3a).

The host-plants of *Altica woodsi* are restricted to the plant genera *Vitis* and *Parthenocissus* in the family Vitaceae.



FIGURE 2. Aedeagus of *Altica woodsi*: a, dorsal view; b, ventral view.



**Traits distinctifs.** Petite espèce allongée, bleu-vert, 3,3-3,8 mm de longueur, à sillon pronotal profond (figure 1b). Chez le mâle, bout de l'édéage triangulaire et légèrement mammelonné au milieu, à carène ventrale médiane et arêtes longitudinales ventrales bien développées (figure 2b). Chez la femelle, styles étroits à marges internes peu divergeantes à l'extrémité (figure 3a).

Les plantes-hôtes d'*Altica woodsi* sont restreintes aux espèces des genres botaniques *Vitis* et *Parthenocissus* de la famille des Vitaceae.

**Description.** BODY. Small elongate species, 3.3-3.8 mm long. (Table III). *Colour* appearing blue or blue-green when alive but with various reflections under the microscope: blue (74%), purplish-violet (21%), or blue-green on pronotum and purplish on elytra (5%); antennae and legs black with blue reflections; tarsi dark reddish brown.

**HEAD.** *Antennae* proportionately longer in males than in females (Table III); antennomeres 3 and 4 subequal in length but both distinctly longer than 2. *Frontal carina* broadly rounded, ending at 2/5 to  $\Omega$  of frontal tubercles. *Frontal tubercles* smooth, weakly defined posteriorly by frontal groove; median frontal groove moderately long, not well defined (5%), short (50%), or moderately developed (45%). *Vertex* smooth or very faintly alutaceous, with few moderately coarse punctures behind eyes. *Eyes* separated by 2.5 times their diameter, not prominent. *Postocular macrochaetae*: 1. *Labral setae*: 6. *Mandibles* with outer and median teeth normal, inner tooth with deep basal indentation, cutting edge straight and rectangular or slightly produced at apex (Figures 3b-d).

**THORAX.** *Pronotum* quadrate, slightly narrower at apex than at base, with sides subparallel in basal half, moderately arcuate towards apex. *Anterior angles* of pronotum obliquely rounded. *Transverse groove* of pronotum deep, extending to lateral margins. *Punctuation* of pronotum moderately dense and fine. *Microsculpture* of pronotum visible but slightly impressed. *Tarsal claws* normal, basal tooth rectangular.

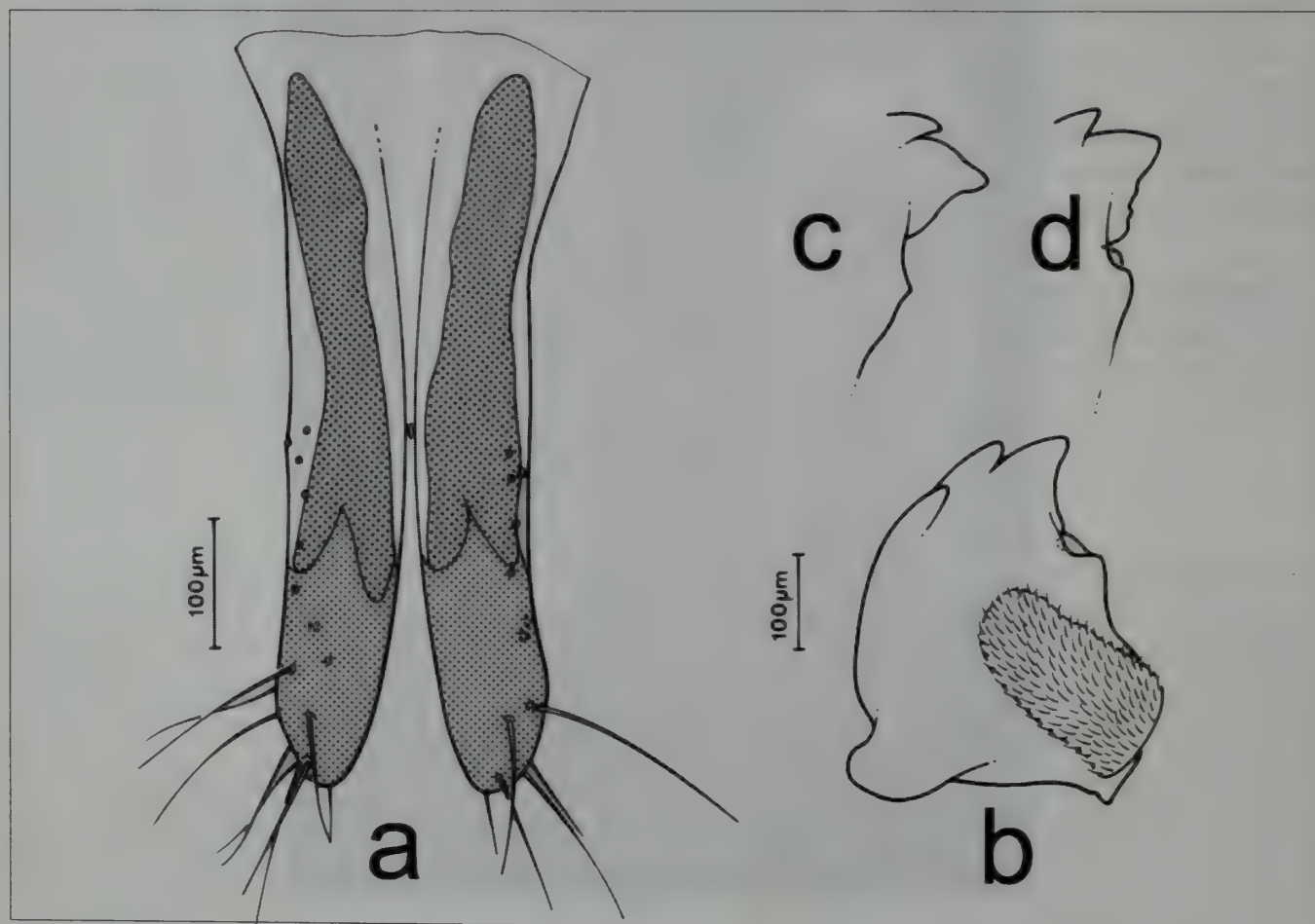


FIGURE 3. *Altica woodsi*: a, styli; b-d, mandible.



Table III. Measurements of body, antennae and pronotum in *Altica woodsi*

	Minimum	Maximum	Mean (n =10)
<b>Male</b>			
Body length (mm)	3.3	3.6	3.5
Body width (mm)	1.8	2	1.9
Body length/ width ratio	1.79	1.94	1.84
Antenna length (µm)	215	230	222
Antenna/ body ratio	0.61	0.67	0.64
Pronotum width (µm)	118	130	124
Pronotum length (µm)	76	84	79
Pronotum width/ length ratio	1.51	1.62	1.57
<b>Female</b>			
Body length (mm)	3.6	3.8	3.7
Body width (mm)	1.9	2.2	2
Body length/ width ratio	1.76	1.87	1.81
Antenna length (µm)	210	220	216
Antenna/ body ratio	0.58	0.62	0.59
Pronotum width (µm)	124	136	128
Pronotum length (µm)	76	86	79
Pronotum width/ length ratio	1.53	1.70	1.62

ELYTRA. *Umbones* not prominent, weakly defined on inner side by small depression. *Elytral costa* absent. *Punctuation* moderately dense, coarser than that of pronotum, moderately coarse and dense, with tendency to be arranged in irregular rows near suture and at base. *Microsculpture* present and deeper than on pronotum.

SEXUAL DIMORPHISM. *Body* slightly more elongate in male than in female (Table II). *Antennae* proportionately longer in male than in female. *First tarsomeres* of front legs slightly broader in male than in female.

MALE GENITALIA. (Table IV). *Median lobe* of aedeagus appearing almost straight in dorsal view (Figure 2a); *tip* triangular, and weakly nipple-shaped in middle; *dorsal undulations* distributed on 1/3 length of aedeagus; *ventral longitudinal ridges* broadly separated by 3/5 width of aedeagus;

TABLE IV. Measurement of male and female genitalia in *Altica woodsi*

	Minimum	Maximum	Mean (n =10)
<b>Male</b>			
Aedeagus length (µm)	116	124	118
Ventral wrinkles	10	12	11.6
<b>Female</b>			
Spermatheca length (µm)	224	256	237
Length of styli (µm)	333	416	381
Apical setae on styles	7	10	9
Sensilla on styles	5	11	9



10-12 *ventro-lateral wrinkles* present, larger towards base, not oblique, and not fused in middle; *median carina* sometimes weak but usually well defined (Figure 2b).

**FEMALE GENITALIA.** (Table IV). *Receptacle* of spermatheca ovoid, larger at base (Figs. 7); *spermathecal pump* cylindrical, not extending beyond base of receptacle; *apical process* present, large (Figure 9a, 9d), or small (Figure 9b, 9c); *spermathecal valve* small; *spermathecal duct* coiled into 2 loops, basal straight portion short; *styli* fused on half their length with inner margins weakly diverging at apex (Figure 3a).

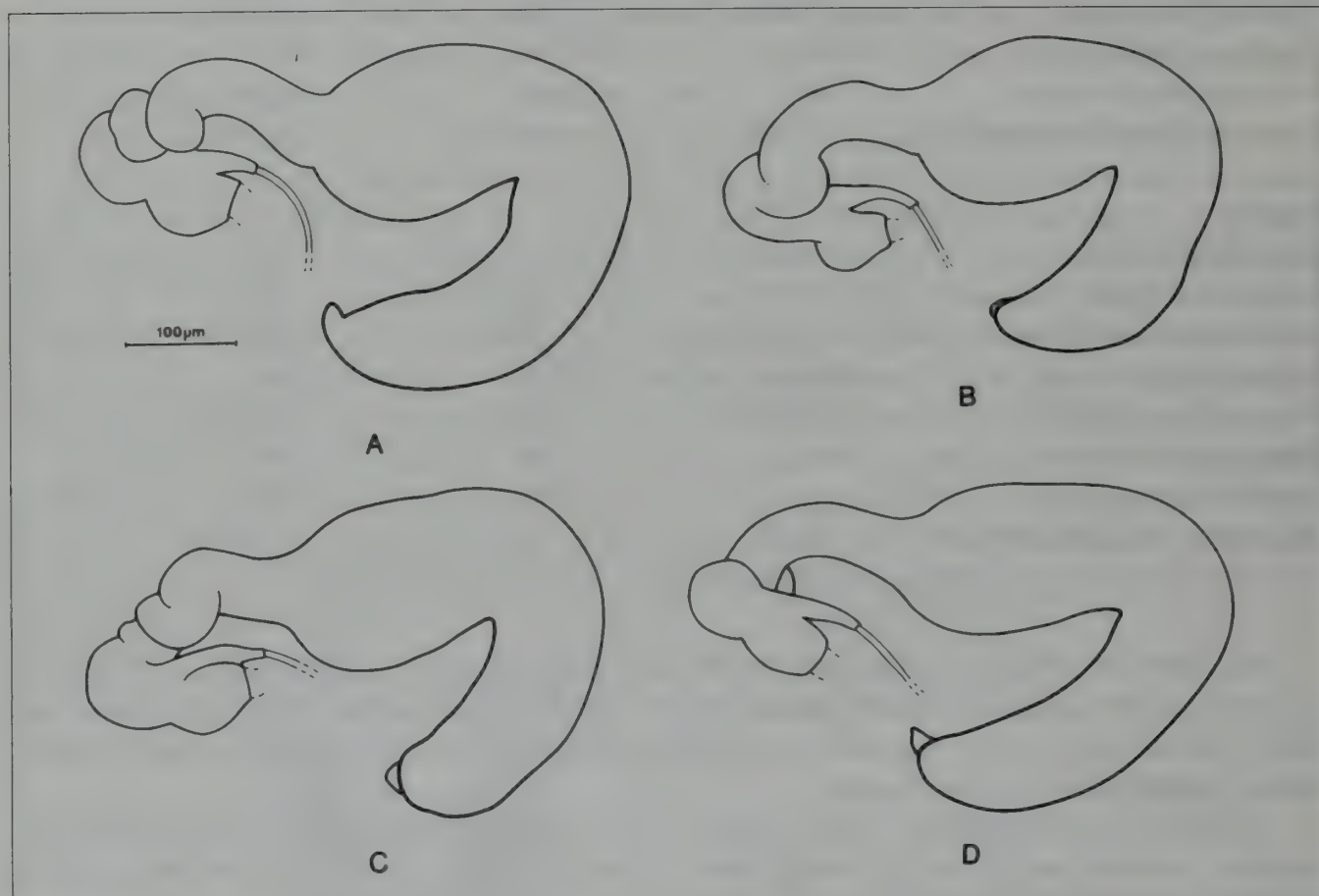


FIGURE 9. Variations of the spermatheca in *Altica woodsi*: a-d

**Remarks.** The female genitalia of *Altica woodsi* are very similar to those of *A. litigata* Fall or *A. suspecta* Fall, the latter probably being a synonym of the former. The spermathecae are virtually identical and the styli differ only by their width, those of *woodsi* (Figure 3a) being proportionally a little broader than in *A. litigata*. However, males of *Altica woodsi* and *A. litigata* are easily separated by the shape of their aedeagus: apex triangular and slightly nipple-shaped in the middle in *A. woodsi*, apex lanceolate in *A. litigata*.

**Type material.** The type series of *Altica woodsi* Isely contains 22 specimens which are deposited in the USNM, in Washington. The holotype bears the following labels: "North East, Pa. 1916/ Quaintance 16427/ Bred from grape/ Reared by D Isely, and a red label *Altica woodsi*, Type no. 22290 U.S.N.M.". Twenty paratypes have the same labels and red label "*Altica woodsi*, Type no. 22290 U.S.N.M."; in the last paratype, the month of the date is given: "VIII.1916". A database tag has been added to these labels: "Database/ LeSage/ *Altica woodsi*/ # 421". Finally, the type series is accompanied by an additional specimen with the same information, but without the red paratype label.



**Literature errors.**

- Larrowe (1862: 382). In his answer to an inquiry of Worden (1862: 350), Larrowe misidentified *Altica chalybea* for *A. woodsi*. His observation concerned *A. chalybea*, but the flea beetles mentioned by Worden were definitely *A. woodsi* since the adults were green, and above all, the eggs were laid on leaves, not inside the buds or in bark cracks as in *A. chalybea*.

- Slingerland (1898: 194). According to Isely (1920: 13) and myself, Slingerland's statement that thin-leaved varieties of grapes were preferred by the grapevine flea-beetle probably refers to *Altica woodsi* instead of *A. chalybea*.

- Marlatt (1896: 395). This author claimed that eggs of *Altica chalybea* were deposited later in the season "in clusters on their lower surface" (of leaves). These comments refer to *A. woodsi*.

- Lugger (1899: 243). At least part of the information given on the host-plants and biology of the adults of "*Haltica ignita* Ill." likely concerns *Altica woodsi*, since the host-plants listed (Grape and Virginia Creeper) are those of *Altica chalybea* or *A. woodsi*. In addition, the habits of the adults to chew into the buds in early spring correspond to what is observed in both species of grape flea beetles.

- Comstock (1880: 214). This author stated that "the eggs [of *Altica chalybea* and *A. woodsi*] are laid in irregular clumps of four or five, more or less, both upon and under sides of the leaf. Rarely a few eggs are to be found upon unopened buds." Oviposition on the upper surface of leaves is unusual for both *Altica chalybea* and *A. woodsi*. *A. chalybea* deposits its eggs primarily on buds, whereas *A. woodsi* does so on the undersurface of leaves.

- Slingerland (1898: 197). Slingerland could not explain the discovery of eggs as late as July 15th on the underside of leaves in a New York vineyard owned by V.H. Lowe. In a footnote in his paper, Slingerland speculated that there could be a second brood in New York. This apparent second generation simply corresponds to the oviposition period of *Altica woodsi*.

Locality records from specimens examined. The following list is based on the examination of 1776 specimens.

**CANADA**

**Ontario.** *Carleton Co.*: Constance Bay (MZELU) 2, Gloucester (CFIM) 12, Harwood Plains (CFIM) 7, Kanata (CFIM) 7, Marshall Bay (CFIM) 1, Mer Bleue (CFIM) 1, (MZELU) 3, Nepean (CFIM) 12, North Gower (CNC) 11, / Marlborough Forest (CNC) 16, Ottawa (CNC) 22, (CFIM) 31, (MZELU) 3, (NDSU) 1, (SMCC) 1, / Hampton Park (CFIM) 3, Shirleys Bay (CNC) 1; *Cochrane Dist.*: Forks Creek River (as "FKS.Cr.R.") (SAMC) 2; *Durham Co.*: Darlington Provincial Park (CFIM) 1; *Essex Co.*: Park (CNC) 1; *Halton Co.*: Halton Hills/ Limehouse (SAMC) 1, Milton (CNC) 2, (SAMC) 2, Oakville (SAMC) 1; *Hastings Co.*: Foxboro (SAMC) 1, Marmora (CNC) 3; *Kent Co.*: Rondeau (CNC) 4, Rondeau Park (CNC) 14, / Marsh Trail (CNC) 3; *Lambton Co.*: Pinery Provincial Park (MZELU) 3, (SAMC) 1; *Leeds Co.*: St. Lawrence Islands National Park/ Aubery Island (CNC) 6, / Camelot Island (CNC) 1, / Gordon Island (CNC) 4, / Grenadier Island (CNC) 11, / Grenadier Island Centre (CNC) 1, / Grenadier Island East (CNC) 6, / Lindsey Island (CNC) 1, / McDonald Island (CNC) 2, / Mulcaster Island (CNC) 1, / Thwartway Island (CNC) 13; *Lincoln Co.*: Vineland (SAMC) 1; *Norfolk Co.*: Port Rowan (CNC) 31; *Northumberland Co.*: Brighton (CFIM) 1, Dundas (SAMC) 2, Ferris Provincial Park (CFIM) 1, Presqu'ile Provincial Park (LEM) 8, (CFIM) 45, (MZELU) 1; *Peel Co.*: Belfountain (now part of Caledon) (SAMC) 1; *Prescott Co.*: Carillon (CNC) 2, Carillon Provincial Park (CNC) 5; *Prince Edward Co.*: county record only: (CDFA) 3, (CNC) 34, (CUIC) 4; *Renfrew Co.*: Arnprior (CNC) 66, (CFIM) 1; *Russell Co.*: Cumberland (ISAC) 16; *Simcoe Co.*: Lefroy (SAMC) 3; *Stormont Co.*: Long Sault/ St. Lawrence River (CFIM) 1; *Thunder Bay Dist.*: Kirby (SAMC) 8; *Wellington Co.*: Damascus (SAMC) 1, Elora (SAMC) 1, Guelph (SAMC) 9, Guelph/ University of Guelph Arboretum/ Goose Wood



(SAMC) 10, Orangeville (SAMC) 1, Rockwood (SAMC) 1; *Wentworth Co.*: Hamilton (CNC) 2; *York Co.*: Keswick (SAMC) 1, Stouffville (SAMC) 1, Toronto (LEM) 1, (SAMC) 3, / Royal Ontario Museum Department of Entomology (ROM) 1, / Zoo (AVMC) 3, Willowdale (SAMC) 1.

Previously reported from this province by Gibson (1913 : 6; 1925: 23; 1926: 578).

**Québec.** *Argenteuil Co.*: île de Carillon (LEM) 2, (CFIM) 1, / (by) Ottawa River (CFIM) 2; *Beauharnois Co.*: île Hébert (CFIM) 1; *Berthier Co.*: Berthierville (CEUM) 87, (CFLQ) 2, (LEM) 87, (CFIM) 1; *Chambly Co.*: Saint-Hubert (LEM) 26, (CFIM) 1, Saint-Lambert/ (by) Saint-Laurent (River) (CFIM) 1; *Champlain Co.*: Longueuil (CFIM) 1, *Châteauguay Co.*: Châteauguay (CEUM) 3, (CFIM) 1; *Deux-Montagnes Co.*: Kanesatake (= Oka) (CCC) 8, (CFIM) 5, La Trappe (CEUM) 56, (CFIM) 1, Oka (CFIM) 1, Parc d'Oka (CFIM) 1, Saint-Eustache (CFIM) 1; *Drummond Co.*: Drummondville (CFIM) 6, Saint-Charles (CFIM) 4; *Gatineau Co.*: Aylmer (CCC) 3, (CFLQ) 4, (CFIM) 134, (UNHC) 2, / bord de la rivière des Outaouais (= edge of Ottawa River) (CFIM) 1, Aylmer; Bouchette/ Lac Roddick (MZELU) 1; *Gatineau Park/ Harrington Lake* (CFIM) 1, / Camp Fortune (CFIM) 1, / Folley Bog (CFIM) 1, / Lac Black (CNC) 1, (CFIM) 1, / Lac Pink (CFIM) 1, / Lac Ramsay (CFIM) 1, / Lac Fortune (CNC) 1, (CFIM) 2, / Lac Mulvihill (CFIM) 4, Lucerne (CFIM) 6, Roddick Lake (= local name for Grand Lac Rond) (CFIM) 1, (MZELU) 1, Wakefield (CNC) 2, (CFIM) 1; *Gatineau and Pontiac Co.*: Gatineau Park (CFIM) 2; *Hull Co.*: Hull (AVMC) 4, (CFIM) 2, / Fairy Lake (CFIM) 1, Hull-Ouest/ Parc de la Gatineau (CFIM) 1, Touraine (CNC) 13, (CFIM) 1, Touraine/ Limbour (CNC) 1, (CFIM) 1; *Iberville Co.*: Iberville/ Vignoble Dietrich-Jooss (CFIM) 33; *Île-de-Montréal Co.*: Beaconsfield (LEM) 3, (CFIM) 1, Dollard-des-Ormeaux (CFIM) 13, Montréal (CEUM) 18, (CNC) 96, (LEM) 6, (CFIM) 21, (USNM) 5, / Bois de Saraguay (CFIM) 6, / Angrignon Park (CFIM) 3, Mount Royal (= Mont Royal) (CFIM) 1, Outremont (CFIM) 1, Sainte-Anne-de-Bellevue (LEM) 106, Sainte-Anne-de-Bellevue (as "Ste. Anne") (CEUM) 4, (LEM) 14; *Île-Jésus Co.*: county record only (as "Laval Co."), Laval (CFIM) 3, Sainte-Dorothée (CFIM) 1; *Lévis Co.*: Lauzon (CFIM) 1; *Lotbinière Co.*: Lotbinière (CFLQ) 9, (CFIM) 1; *Maskinongé Co.*: Maskinongé (CFIM) 1; *Pontiac Co.*: Fort-Coulonge (CFIM) 2, Lac Davis (CFIM) 1, Quyon (CFIM) 1, Shawbridge (LEM) 4, (CFIM) 1; *Portneuf Co.*: Neuville (CFLQ) 14, (CFIM) 1, Saint-Augustin (CCC) 5, (CFLQ) 1, (CFIM) 1; *Québec Co.*: Sainte-Foy (CFLQ) 1; *Rouville Co.*: Ange-Gardien (CFLQ) 2, (CFIM) 1, Saint-Hilaire (CFIM) 1; *Saint-Jean Co.*: Saint-Jean (CNC) 2, (CFIM) 1; *Soulanges Co.*: Côteau-du-Lac (CFIM) 1; *Vaudreuil Co.*: Choisy (CFIM) 1, Île Perrot (CFIM) 1, Pincourt (CNC) 23, (CFIM) 1, Rigaud (CCC) 5, (CEUM) 1, (CNC) 1, LEM) 1, (CFIM) 31, / (by) Ottawa River (CNC) 3, (CFIM) 16; *Yamaska Co.*: Yamaska (CNC) 3, (CFIM) 1.

Not located: only a code "59-45" (CFLQ) 2.

Previously recorded for this province by Couper (1881; 219) and Gibson (1925: 23).

## UNITED STATES

**(Alabama).** Previously recorded from this state by Downie and Arnett (1996: 1374). State record not confirmed by the present study.

**Connecticut.** *New Haven Co.*: New Haven (YPMC) 2.

**District of Columbia.** District record only: (CNC) 1, Washington (USNM) 2.

**Illinois.** *Cook Co.*: Glencoe/ Turnbull Woods (INHS) 1, / Riverside Wood (INHS) 1; *Knox Co.*: Galesburg (MCZ) 1; *McDonough Co.*: Macomb (NDSU) 1.

**Indiana.** *Kosciusko Co.*: county record only (PURC) 2; *Marshall Co.*: Tippecanoe (as "Tipp.") CAS 1; *Posey Co.*: county record only (PURC) 2.

Not located: (locality name illegible) (PURC) 1.

**Kansas.** *Crawford Co.*: county record only (ISAC) 1.

**Louisiana.** *Madison Co.*: Tallulah (CDFA) 1.



**Maryland.** State record only: (CNC) 1; *Anne Arundel Co.*: Odenton (USNM) 1; *Baltimore Co.*: Baltimore (CAS) 2; *Montgomery Co.*: Glen Echo (USNM) 3, Plummers Island (USNM) 2; *Prince George's Co.*: Bowie/ Patuxent Refuge, Laurel (CNC) 1.

Previously recorded from this state by Staines and Staines (1998: 239).

**Massachusetts.** *Hampden Co.*: Chicopee (USNM) 2 Longmeadow (USNM) 1.

**Maine.** *Kennebec Co.*: Waterville (RENC) 5; *Penobscot Co.*: Orono (CNC) 1, (USNM) 1.

**Michigan.** *Barry Co.*: Gull Lake/ 8 mi. S Delton (CNC) 8; *Berrien Co.*: Saint Joseph (CAS) 1; *St. Joseph* (as "St. Joe") *Co.*: county record only (EGRC) 1.

**Minnesota.** *Anoka Co.*: Ramsey (CNC) 2; *Hennepin Co.*: Saint Anthony Park (CNC) 1; *Sherburne Co.*: Elk River (CNC) 1.

**Missouri.** *Barry Co.*: Roaring River State Park (EGRC) 1; *Frederick Co.*: Frederick Municipal Forest (EGRC) 1; *Madison Co.*: 3 mi. W Fredericktown (EGRC) 2; *Randolph Co.*: 1 mi E Moberly (EGRC) 16, (RHTC) 1; *Saline Co.*: Van Meter State Park/ Woolbridge Lake (EGRC) 1.

**New Hampshire.** *Coos Co.*: Gorham (CNC) 3; *Grafton Co.*: Bedel Bridge/ S.P. Oliverian Brook (UNHC) 42.

**North Carolina.** *Jackson Co.*: Balsam (USNM) 8; *Robeson Co.*: Lumberton (USNM) 1; *Swain Co.*: Bryson City (USNM) 1, Indian Gap (USNM) 5.

**New Jersey.** State record only: (MCZ) 2; *Warren Co.*: Phillipsburg (CAS) 5.

**New York.** State record only: (USNM) 3; *Essex Co.*: Whiteface Mountain (EGRC) 1; *Jefferson Co.*: One Thousand Island Park/ Wellesley Island (MZELU) 3; *Monroe Co.*: Rochester (NDSU) 1; *Nassau Co.*: Inwood (USNM) 2; *New York Co.*: New York (CNC) 2; *Niagara Co.*: Olcott (CUIC) 2; *Orange Co.*: West Point (USNM) 19; *Richmond Co.*: Staten Island (MCZ) 1, Staten Island (as "S.I.") (USNM) 5; *Suffolk Co.*: Huntington (in Long Island) (CUIC) 1, Riverhead (NDSU) 2; *Tompkins Co.*: Ithaca (CUIC) 29, Lansing Monkey Run, Taughannock Falls/ 8 mi. N. of Ithaca (CUIC) 28; *Westchester Co.*: Montrose (USNM) 1.

Previously recorded from this state by Isely (1920: 13), Leonard (1928: 477), Wilcox (1975: 110) and Downie and Arnett (1996: 1374).

**North Carolina.** *Jackson Co.*: Balsam (USNM) 6.

**Ohio.** *Lake Co.*: Headlands (USNM) 2.

**Oklahoma.** *Pittsburg Co.*: McAlester (USNM) 1.

**Pennsylvania.** State record only: (CNC) 3; *Dauphin Co.*: Paxtang (NDSU) 2; *Delaware Co.*: Castle Rock (SMCC) 1, Glenolden (MCZ) 2; *Erie Co.*: North East (CNC) 5, (USNM) 22 [type locality]; *Montgomery Co.*: Miquon (NDSU) 1; *Northampton Co.*: Easton (CAS) 12.

Not located: Hanover (USNM) 3 (county not specified, many possibilities).

Previously recorded from this state by Isely (1920: 13), Gibson (1925: 23) and Downie and Arnett (1996: 1374).

**South Carolina.** *Chesterfield Co.*: Sandhill State Forest (FAMU) 1.

**Tennessee.** *Washington Co.*: Johnson City (CAS) 3.

**(Texas).** Recorded from this state by Wilcox (1974: 110) and Downie and Arnett (1996: 1374).

**Vermont.** *Chittenden Co.*: Burlington (CNC) 3.

**Virginia.** State record only: (USNM) 1; *Fairfax Co.*: Black Pond (USNM) 1, Great Falls (USNM) 1; *Lee Co.*: Pennington Gap (USNM) 1; *Loudoun Co.*: near Plummers Island (in MD) (USNM) 1; *Pulaski Co.*: Mechanicsburg (MZELU) 1; *Shenandoah Co.*: New Market (CNC) 3; *Southampton Co.*: Boykins (MCZ) 1; *Virginia Beach City.*: Cape Henry (USNM) 9, Virginia Beach (CNC) 1.

**West Virginia.** *Cabell Co.*: 1 mi. S Dudley Gap (SMCC) 1; *Doddridge Co.*: Randolph (CFIM) 1; *Fayette Co.*: Hawks Nest State Park (SMCC) 2; *Kanawha Co.*: Ruthdale (SMCC) 1, Guthrie (SMCC) 17, Kanawha State Forest (SMCC) 3, Shrewsbury Hollow (SMCC) 1; *Pleasants Co.*:



Belmont (SMCC) 1; *Ritchie Co.*: 1.5 mi. W Stanley (SMCC) 1; *Summers Co.*: New River at Sandstone (SMCC) 1, Pipestem (MZELU) 1.

Previously recorded from this state by Clark (2000: 34).

**Wisconsin.** *Dane Co.*: Baskerville Park (CDFA) 2, (CDFA) 3, (EGRC) 1, (NDSU) 1, (USNM) 1.

**Distribution.** *Altica woodsi* is a Northeastern species distributed from Ontario and Québec to South Carolina and Louisiana (Figure 10). The distribution of *Altica woodsi* is similar to that of *A. chalybea* but does not include the Gulf States. Louisiana is considered here an extension of the natural distribution due to grape growing. Alabama and Texas recorded by authors (see above) are doubtful records that have not been confirmed by voucher specimens.



FIGURE 10. Distribution of *Altica woodsi* in North America.

**Host-plants.**

a) True host-plants mentioned in the literature

- *Delaware* grape (a variety of *Vitis riparia* Michx.): as “...of the cultivated grapes the larva flourishes on thin-leaved varieties like the Delaware” by Isely (1920: 13)

- *Concord* grape (a variety of *Vitis labrusca* L.): as “Larvae were frequently found on Concord grapes in the field but the majority of the newly hatched larvae placed on Concord leaves in cages failed to pass the first instar. After this instar was passed little difficulty was experienced in carrying them to the adult stage.” and “but does not favor thick-leaved sorts like the Concord” *fide* Isely (1920: 13).

- Cultivated grape (= *Vitis vitifera* L.): Isely (1920: 13); Gibson (1925: 24; 1926: 578).

- *Parthenocissus quinquefolia* (L.) Planch. (or as “Virginia Creeper”): Gibson (1925: 24, 1926: 578), Wilcox (1979: 16); Downie and Arnett (1996: 1374).

- *Parthenocissus* sp.: Wilcox (1979: 16); Downie and Arnett (1996: 1374).



- *Vitis* spp. (or as "Grape"): Wilcox (1979: 24); as "wild and cultivated grape" by Isely (1920: 13); Downie and Arnett (1996: 1374).

- *Vitis riparia* Michx. (Wild Grape): (Gibson 1925: 24).

b) Accidental host-plants mentioned in the literature.

- None found so far.

c) True host-plants recorded on the labels of specimens examined

- "Grape *ampelopsis*" (*Parthenocissus quinquefolia* (L.) Planch.): 1 record.

- "Cultivated Grape" (*Vitis vitifera* L.): 2 records.

- "Grape", "Grapevine", (*Vitis* spp.): 26 records

- *Parthenocissus quinquefolia* (L.) Planch. (Virginia Creeper, "Virginia Grape"): 28 records.

- "Wild Grape", "Wild Vitis" (*Vitis riparia* Michx. ): 14 records.

d) Accidental host-plants recorded on the labels of specimens examined:

- *Amelanchier* sp. (blooming): 1 record.

- "Asclépiade" (*Asclepias syriaca* L.): 1 record.

- *Avena sativa* L.: 1 record.

- *Barbarea vulgaris* R. Br.: 1 record.

- *Carex* sp.: 1 record.

- *Cassandra* sp. (probably *calyculata* (L.) D. Don): 1 record.

- *Cornus* sp.: 1 record.

- *Cornus stolonifera* Michx.: 7 records.

Note: Wild Grape and Virginia Creeper often grow intermixed with Dogwood in Ontario and Québec where the beetles with this host-plant were collected. This may explain the large number of records of this accidental host.

- "Hawthorn" (*Crataegus* sp.): 1 record.

- *Nasturtium* sp.: 1 record.

- "Plants" (undetermined): 2 records.

- *Populus* sp.: 2 records.

- "Red Cedar" (*Juniperus virginiana* L.): 1 record.

- "Spurge" (*Euphorbia cyparissias* L.): 1 record.

- "Sunflower" (*Helianthus* sp.): 1 record.

- *Populus tremuloides* (Michx.): 1 record.

- *Prunus* sp.: 1 record.

- *Salix* sp. : 1 record.

- *Salix lucida* Mühl. (= Shining Willow): 1 record.

- *Scirpus* sp.: 1 record.

- *Solidago* sp.: 3 records.

- *Tilia americana* L. (= Tilleul d'Amérique, Basswood): 1 record.

- "undetermined grass": 1 record.

- "Wheat" (*Triticum aestivum*. L.): 1 record.

**Biology.** *Altica woodsi* overwinters in the adult stage. Overwintering adults hide in leaf litter, under the rough bark of trees or in the crevices of wood not far from their host plants, and look for winter quarters at the time the leaves of the grape start to fall. According to the information recorded on the labels of specimens examined, habitats recorded included deciduous, poplar, beech/maple, pine, mixed and flood plain forests, the edges of forests, lakes, rivers, creeks, ditches and roads, as well as vineyards, gardens, picnic areas, and abandoned fields.



Most of the biological information dealing with *Altica woodsi* comes from the original work of Isely (1920), and the contribution of Gibson (1925) in Ottawa, Ontario. Earlier observations exist but they were published under different species names (*A. chalybea* Illiger, *A. ignita* Illiger, etc.; see Literature review). Peairs (1941) claimed that adults of *A. woodsi* emerged from hibernation in early spring and fed on the foliage that was already expanded. However, according to Lugger (1899), and from my own observations made in the Ottawa area in spring 2001 and 2002, overwintering adults were chewing into the leaf buds of the wild grapes before they opened, just as those of *A. chalybea* do. They usually attack cultivated grapes soon after if vineyards are present in the surroundings. Hibernated adults feed for 1-2 weeks before mating and ovipositing.

As correctly reported by Gibson (1925), eggs are usually laid singly along the veins on the underside of leaves, but sometimes, two or three may be deposited together. The eggs are pale yellow in colour, typically with a narrow line of feces stuck on one side. According to Isely (1920), the largest number of eggs deposited by a female in a single day was 31. Females kept under observation by this author deposited 37-181 eggs during their lifetime, for an average of 102.5 eggs per female. Incubation time depended considerably on weather conditions, but, in general, eggs hatched within 2 weeks.

Newly hatched larvae eat only the under surface of leaves, whereas larger ones make holes through the blade (Figure 11a). There are 3 larval instars. Each instar lasts about 6 days (Isely 1920). Larvae prefer thin-leaved grape varieties, and do not move readily from one leaf to another. The larval period lasts 18 days.

Pupation occurs underground, 1-2 cm under the surface, in a pupal chamber made of packed soil material. The pupation period lasts about a week, but may vary considerably according to the local weather conditions. The pupa is yellow.

First adults of the new generation appear at the end of July and beginning of August. Like large larvae, they typically make irregular feeding marks on leaves (Figure 11b). Adults feed on their host for the rest of the season but without mating or ovipositing. They look for shelters with the arrival of the first cold night in the fall.

According to my observations there is only one generation a year in the Ottawa area, but Gibson (1925) reported that females of the new generation maintained in cages produced eggs in mid-August, suggesting two generations, at least in some years.

**Parasites.** They probably exist, but none have yet been identified.

**Predators.** In Aylmer, Québec (north of Ottawa, Ontario), adults of the carabids *Lebia moesta* LeConte and *L. viridis* Say were collected by myself in company of adults of *Altica woodsi*.

**Economic importance.** Damage to grapes has been reported as minor since *Altica woodsi* feed exclusively on the developed leaves of grape (Isely 1920; Peairs 1941). However, my colleague, Henri Goulet, lost all of his Concord grapes in summer 2001 due to this pest. I have observed spring adults during the first week of May 2001, and in mid-April in 2002, feeding on opening buds of wild grape along the Ottawa River. In two vineyards of the Eastern Townships in Québec, adults of both *A. woodsi* and *A. chalybea* were collected on canes in early spring 2001, but it could not be determined whether they were feeding on leaf or fruit buds (Martin Trudeau, pers. comm.).

**Common names.** Lugger (1899: 243) first proposed the popular name “Lesser grapevine flea-beetle” but erroneously applied it to *Altica ignita*. The name was later used by Isely (1920: 11) when he described *A. woodsi*, and accepted by Herrick (1925: 177), Gibson (1925: 23, 1926: 578), and Peairs (1941: 323). Surprisingly, it is not included in the lists of the common names of insects produced by the Entomological Society of America (Muesebeck 1942; Werner 1982; Stoetzel 1989; Bosik 1997).



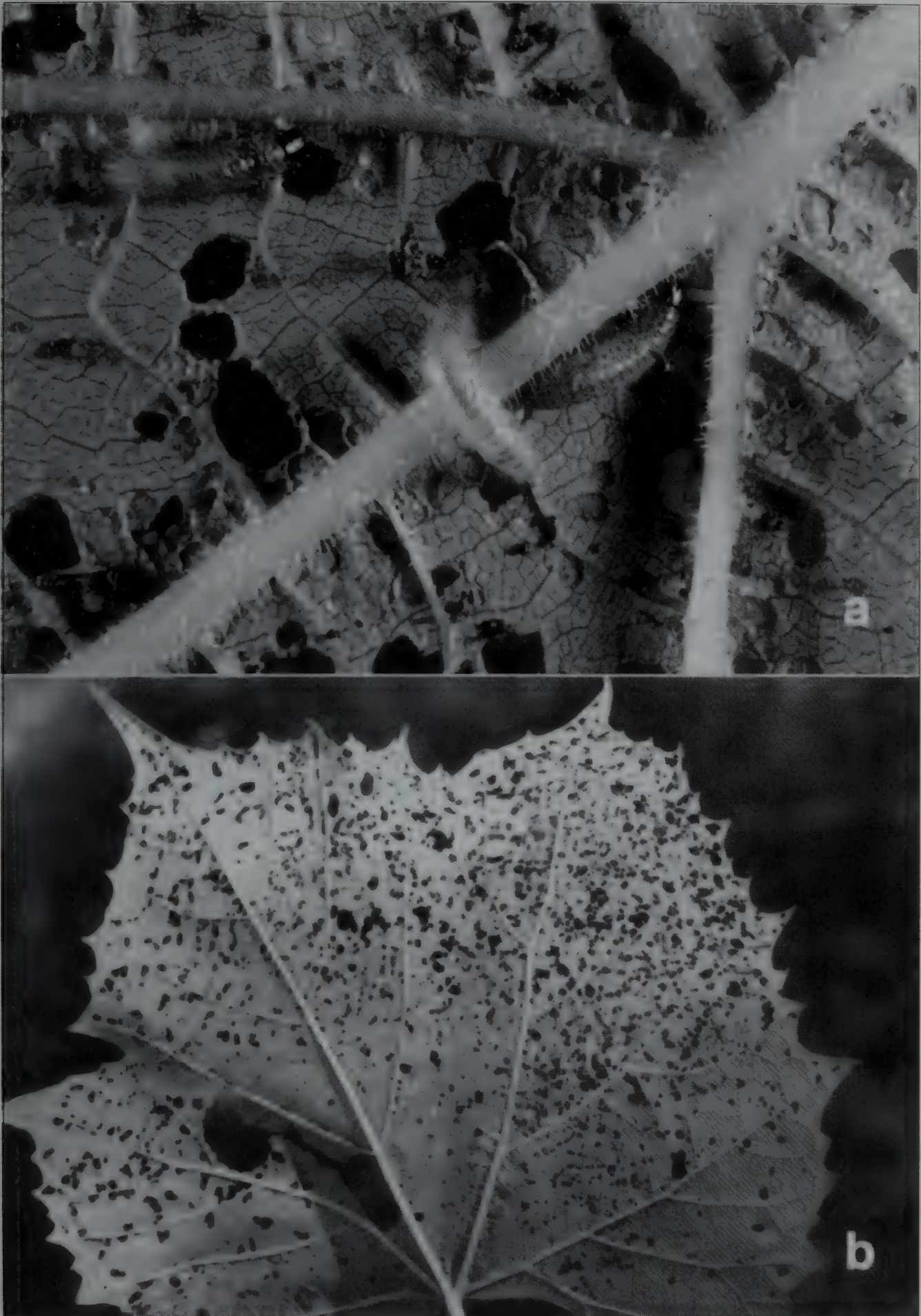


FIGURE 11. a, underside of a leaf of *Vitis riparia* damaged by larvae of *Altica woodsi*; b, leaf of the same plant typically riddled with holes by adults of the new generation and large larvae.



Benoit (1975: 26, 1985: 10) proposed the French name "*Altise de Woods*" for *Altica woodsi*, in reference to the species name *woodsi* with the English equivalent "*Wood's flea beetle*." Unfortunately, few people are aware that Woods was an entomologist who studied the biology of *Altica*, so it is not a useful common name. Alternatively, since most *Altica* species are mono- or oligophagous, it is usually easier to identify them indirectly by their host-plants than directly by their morphological external features. Consequently, the proper French equivalent of the *Lesser grapevine flea beetle* should be "*Petite altise de la vigne*".

### Conclusion

Although both *Altica chalybea* and *A. woodsi* develop on the same host-plants (*Vitis*, *Parthenocissus*), slight differences exist in their habits that reduce interspecific competition. For instance, *A. chalybea* lays its eggs on buds or in bark crevices, whereas *A. woodsi* does so on the underside of leaves later in the season. More data are needed to confirm early observations of authors on egg hatching and larval development of *A. chalybea* which are supposed to occur 2-3 weeks later in *Altica woodsi*.

With regards to larval habits, the larvae of *Altica chalybea* are usually found on the upperside of leaves according to authors, whereas those of *A. woodsi* commonly develop on the underside. However, rarely were larvae of *A. chalybea* found on the upper surface in rearings maintained in the laboratory in 2002. Also, it is not known whether the larvae of both species can feed together on the same leaf in nature. More information is also needed on the morphology of the larvae since it is presently impossible to recognize individual instars or separate larvae of both species using the existing descriptions or illustrations (Slingerland 1898; Isely 1920). Such information is essential for understanding how the larvae of two species can share the same food source. Do they feed on the same plant without serious competition by sharing different portions of the canes? Within a given habitat, or vineyard, do they develop in different areas to reduce competition? At present, the answers to these questions are still unknown. The same lack of information applies to the pupae. Finally, an extensive search for parasites would be of great interest for pest management in vineyards.

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## AN UNUSUAL NEW SPECIES OF *PEDARIDIUM* HAROLD (COLEOPTERA: SCARABAEIDAE: ATEUCHINI) FROM COLOMBIA<sup>1</sup>

BRUCE D. GILL<sup>2</sup>  
FERNANDO Z. VAZ-DE-MELLO<sup>3</sup>

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### Abstract

A new species from Colombia, *Pedaridium medinae* n. sp. is described and illustrated. This new species is readily distinguished from all others in the genus by the lack of eyes on the dorsal surface of the head and by several unusual secondary sexual characters in the male.

**Keywords.** Ateuchini; Colombia; new species; *Pedaridium*.

### Introduction

The Ateuchini genera *Pedaridium* Harold, 1868 and *Trichillum* Harold, 1868 currently include some 50 described species of small to medium-sized dung beetles (2 to 7mm in length). While the generic limits are not well-defined, both of these strictly Neotropical taxa appear to be polyphyletic and are currently under study by the second author.

The purpose of this paper is to describe an unusual new species to facilitate ongoing faunistic studies in Colombia (Medina and Lopera 2001, Medina *et al.* 2002). This new species is placed in the genus *Pedaridium* based on a gradually expanded epipleuron, a diagnostic character used for separating *Pedaridium* from *Trichillum* in a recent revision by Ferreira and Galileo (1993).

### Material and Methods

Specimens of this new species were collected by the senior author in relict patches of Andean forest using pitfall traps baited with human dung. Additional specimens were borrowed from, or are deposited in, the following collections (curators in parentheses):

- BDGC Bruce D. Gill personal collection, Ottawa, Canada.  
CAMC Claudia A. Medina personal collection, Cali, Colombia.  
CMNC Canadian Museum of Nature, Ottawa, Canada (H. F. Howden and François Génier).  
CNCI Canadian National Collection of Insects, Ottawa, Canada (Anthony Davies).  
IAHC Instituto Alexander von Humboldt, Villa de Leyva, Colombia (Fernando Fernández).  
FZVC Fernando Z. Vaz-de-Mello personal collection, Lavras, Brazil.

Photographs were taken on a Phillips ESEM scanning electron microscope by T.E. Dare of Buckham's Bay, Ontario using uncoated specimens.

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<sup>2</sup> Entomology Unit, Centre for Plant Quarantine Pests, Canadian Food Inspection Agency, 960 Carling Avenue, Ottawa, Canada, K1A 0C6. E-mail: gillbd@inspection.gc.ca

<sup>3</sup> Departamento de Biologia, and Departamento de Entomologia, Universidade Federal de Lavras, Lavras MG 37200-000, Brazil. E-mail: scarab@ufla.br

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## Results

### *Pedaridium medinae* Gill & Vaz-de-Mello, n. sp.

**Males.** 3.8 – 4.8 mm in length. Body elongate-oval; dorsal surface of body (head, pronotum and elytra) dark gray to dark brown in colour, ventral surface of body and legs dark brown. Punctures on dorsal surface with long reddish-orange setae or much smaller yellowish setae; punctures on ventral surface with predominantly smaller, yellowish setae.

Head (Figure 1). Clypeus anteriorly with two small teeth, separated by a broad U-shaped emargination. Emargination bordered with indistinct carina connecting bases of clypeal teeth. Ventral surface of emargination carinate, forming small median denticle. Lateral margin of clypeus evenly arcuate to gena. Gena abruptly angulate. Clypeal surface coarsely punctate; anteriorly with mixture of small and large punctures, posteriorly with larger, more uniformly-sized punctures. Frons and vertex with large, closely-spaced punctures; punctures with scattered setae. Eyes not visible dorsally.

Pronotum with border unmargined except for small area at posterolateral angle. Disc coarsely, densely punctate except for small impunctate callus near lateral margin; punctures similar to those on frons, but larger, especially basally. Anterior angle obtuse, posterior angle rounded, lateral margin sinuate.

Elytron (Figure 2) with disc anteriorly flat, posteriorly convex; with rows of long and short setae. Sutural stria simple; discal striae consisting of single rows of large, contiguous, deeply-impressed ocellate punctures; diameter of ocellate punctures approximately one-half to two-thirds interstrial width, punctures forming unbroken chain from base to apex of elytron. First and second discal striae deeply impressed at apex; lateral stria deeply impressed throughout length. Elytral intervals with two rows of small, shallowly-impressed punctures.

Mesosternum covered by large setose punctures; punctures smaller and more rounded anteriorly. Meso-metasternal suture angulate medially; apex of angulation directed anteriorly. Metasternum densely, closely punctured; punctures larger anteriorly and laterally though smaller than those of mesosternum; disc of metasternum shallowly concave, hind margin with bifid tubercle along midline, close to posterior coxae.

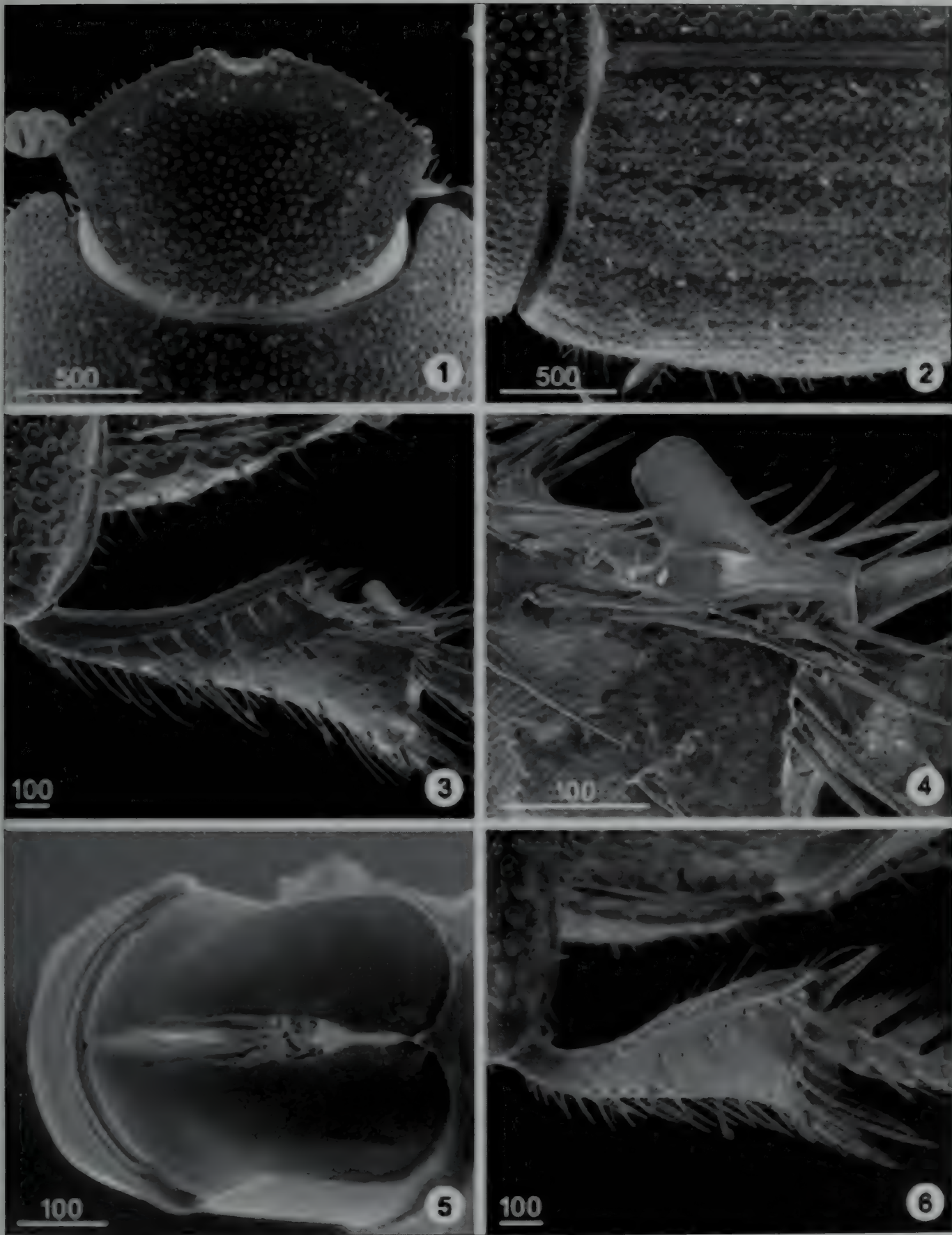
All femora densely, closely punctured on ventral face. Fore tibia externally with three small teeth in apical half; inner apical angle projecting inwardly as tooth. Fifth tarsomere laterally compressed and apically dilated. Middle tibia gradually expanded to apex, obtusely truncate apically, with inner apical angle projecting inward as small tooth. Hind tibia strongly expanded apically; outer margin straight, inner margin strongly curved for about two-thirds length to obtuse angle, thence abruptly incurved to apex near insertion of metatarsus; inner apex bearing broad laminar process directed basally (Figures 3-4). First tarsomere longer than second, fifth tarsomere about twice as long as fourth. Tibial spurs simple, conical. Tarsal claws very small, strongly curved.

Abdominal sternites and pygidium densely, closely punctured; base of pygidium with shallow transverse sulcus. Propygidial apex with U-shaped emargination at midline. Parameres of genitalia as in Figure 5.

### **Females.**

Similar to males except as follows. Lateral margin of pronotum almost rounded, not sinuate. Metasternal disc flat and without apical bifid tubercle. Fore tibia without internal apical tooth, with external teeth more strongly developed. Fifth tarsomere of fore tibia not expanded apically. Middle tibia lacking internal apical tooth. Hind tibia lacking both internal apical concavity and laminar process (Figure 6). Abdominal sternites longer along midline, pygidium shorter.





FIGURES 1-6. *Pedaridium medinae* n. sp.: 1. Head, dorsal view; 2. Elytron, dorsal view; 3. Hind tibia of male; 4. Hind tibia of male, detail; 5. Parameres of male genitalia, dorsal view; 6. Hind tibia of female. Scale bars in microns.



### Type Material

HOLOTYPE male: COLOMBIA: Risaralda: PNR Ucumari, La Pastora, 2400 m Aliso, T. Exc. H., C. Medina, Mayo 7 1995 (IAHC).

ALLOTYPE female: COLOMBIA: Risaralda: PNR Ucumari 1800m, La Suiza, Bosque, T. Exc. H., C. Medina, Marzo 29 1995 (IAHC).

PARATYPES: 20 specimens; 8 males, 9 females, and 3 not recorded. COLOMBIA: Cundinamarca: Tecadama (*sic*) [= Tequedama?] Falls, 30 km SW Bogotá, 27-II-6-III-1972, S&J Peck, forest dung trap (1 specimen, CMNC); Quindio, 5 km E Salento, 1800 m, 9-XII-1995, BD Gill, dung trap (8 specimens, BDGC; 1 specimen, CMNC; 1 specimen, CNCI; 4 specimens, FZVC); R Herencia Verde, 1800 m, 12-XII-1995, Medina & Gill, excr hum. (1 specimen, CAMC); Risaralda: Pereira, SFF Otún Quimbaya, Est. La Suiza, 1850 m, 25-IV-04-V-1997, A Vitolo (1 specimen, FZVC); Pque. Nat. Reg. Ucumari, La Suiza 1800 m, CA Medina (1 specimen, CMNC); Pque. Nat. Reg. Ucumari, La Suiza 1800 m, 29-III-1995, F Escobar, excr hum. (2 specimens, CAMC).

Etymology: This new species is named in honour of Claudia A. Medina, a specialist in the systematics of Canthonine scarab beetles, who collected part of the type series.

### Discussion

The type series exhibits little variation with the exception of the larger setae which appear to be subject to abrasion, being sparse on several of the older, more abraded specimens.

This species is unique among known *Pedaridium*, being distinguished by the absence of eyes on the dorsal surface of the head and in the unusual secondary sexual characters of the male, most



FIGURE 7. Distribution of *Pedaridium medinae* n. sp in Colombia.



notably the metasternal tubercle and distinctive hind tibia. Males of *Pedaridium bordoni* Martínez (1992) from Venezuela also share a toothed inner apical angle of the fore tibia, and a broad laminar process at the inner apex of the hind tibia. In *P. bordoni* however, the middle tibia is not apically toothed and the hind tibia lacks the concave excavation on the inner apical margin.

*Pedaridium medinae* can be readily recognized by the dorsal absence of eyes and the rows of large ocellate punctures on the elytra. It appears to be confined to Andean forests in the Provinces of Risaralda, Quindio and Cundinamarca in Colombia (Figure 7) and is now the second species of the genus to be reported for the country (see Medina *et al.* 2002).

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## Screening Onion Breeding Lines for Resistance to Onion Maggot (*Delia antiqua* Meigen) Damage

M.R. MCDONALD, K. VANDER KOOI, B. KORATOWSKA and S. JANSE  
Dept. of Plant Agriculture, University of Guelph  
Guelph, ON N1G 2W1

Corresponding author: MARY RUTH MCDONALD  
email: [mrmdona@uoguelph.ca](mailto:mrmdona@uoguelph.ca)

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### Abstract

Investigations were carried out from 1995 to 1997 to screen onion breeding lines for resistance to onion maggot (OM) damage. Injury levels to direct-seeded and transplanted lines (altogether 35 entries) and 2 commercial cultivars at the seedling and mature bulb stage were evaluated in experimental plots in the Holland Marsh, southern Ontario, Canada. Differences in resistance expression were identified. The lines that tended to be most resistant to maggot damage were of the PS WR series. These were developed by PetoSeeds using germplasm from the onion breeding program at the University of Wisconsin, which focused on increasing resistance to *Allium* white rot. Expression of resistance was most evident at the seedling stage; in most cases differences in resistance were not as distinct at harvest. Levels of bulb damage were related to levels of seedling loss in onions grown from transplants but not in direct-seeded onions. Resistance studies on seeded and transplanted onions should be studied separately, since planting method can affect resistance ranking.

### Introduction

The onion maggot (*Delia antiqua* Meigen, Diptera: Anthomyiidae) (OM) is a severe insect pest of onion (*Allium cepa* L.) crops grown in temperate regions of the northern hemisphere. This palearctic species was introduced into North America in the 19<sup>th</sup> century (Loosjes 1976). It dispersed throughout the continent, becoming one of the most important insect pests of onions grown in Canada (Harris et al. 1981; Ritcey and Chaput 2000). Although its host range extends to all *Allium* vegetables (Ellis and Eckenrode, 1979; McFerson et al. 1996) severe infestations, and resulting stand and yield losses, have been most often reported in onion crops (Baker 1927; Loosjes 1976; Harris et al. 1981; Brewster 1994). If not controlled, onion maggot infestations can prevent the production of marketable crops (Tolman et al. 1986).

In the climatic conditions of southern Ontario, onion yield on muck (organic) soils is higher and cost of production is lower than on mineral soils (Valk 1988). More than 60% of Ontario's onion crop (approximately 68,000 tonnes) is grown on the muck soils of the Bradford Holland Marsh (OMAFRA 1995). Spring sown bulbing onions are most common and comprise more than 1500 ha. Some early maturing cultivars are grown from seedlings started indoors and transplanted into the field as soon as weather and soil conditions permit (Valk 1988).

Onion production on muck soils is favourable for the development of OM (Perron 1972). In the Bradford area, newly emerged adults mate in mid-May. Gravid females deposit eggs in the soil around the base of onion seedlings. Females can deposit approximately 200 eggs during their life-



time of about 30 days. Eggs hatch after several days and larvae start feeding on the subterranean part of the onion stem and, after bulb formation, on onion bulb tissue. Larvae mature in two to three weeks and leave the plant to pupate in soil (Ritcey and Chaput 2000).

Onions are most susceptible to OM damage when the first generation larvae are present (late May to beginning of July) and often, infested seedlings die before the maggots are fully grown. This damage results in stand loss and reduction in yield and quality. There is some compensation in yield, through increased growth of neighbouring onions, however, since damage tends to be clustered, empty sections of row and uneven growth in the remaining onions develop and reduce crop quality. During the second (mid-July) and third (late August and September) generations, the onion bulbs are larger and feeding by larvae does not kill plants; however, damaged bulbs are not marketable, so the proportion of damage is directly related to loss of marketable yield. Furthermore, damage caused by second and third generation maggots can predispose bulbs to rot as a result of secondary infections of fungi or bacteria (Loosjes 1976; Brewster 1994).

The most commonly used control measure is the application of insecticide to the soil to control first generation maggots. Later in the growing season, sprays may be applied to control adults (Harris et al. 1981; Liu et al. 1982). Intensive insecticide use has resulted in high mortality of natural enemies of the onion fly (Carruthers et al. 1985), and in the development of resistance in OM to several insecticides (Harris and Svec 1976; Carroll et al. 1983). Both insecticide resistance and environmental concerns limit utilization of chemical methods in OM control programs (Finch et al. 1986; Walters and Eckenrode 1996). Thus, there is a compelling demand for alternative control measures.

Plant resistance to insect damage is an attractive alternative or supplement to chemical control strategies. Resistance of various *Allium* species to OM infestation and damage has been studied by several workers (Harris et al. 1987; McFerson et al. 1996). Ellis and Eckenrode (1979) provided a general review of *Allium* and concluded that low levels of resistance may exist in bulb onions. The results of Ellis et al. (1979) and Eckenrode and Walters (1997) showed significant differences in resistance to OM damage among breeding lines evaluated throughout the time of first and second generation damage (late May through early July). We report here on the results of a three-year field study to screen seeded and transplanted onion lines for resistance to OM damage.

## Materials and Methods

### *Plant material*

Breeding lines, initially developed for disease resistance to *Allium* white rot (*Sclerotium cepivorum* Berk.), were obtained from Asgrow Seed Co., Ontario, Canada; Petoseed Co., California, U.S.A.; and the University of Wisconsin, Dept. of Horticulture (Dr. I. L. Goldman), Madison, WI, U.S.A. Seeds of the commercial cultivars, Norstar and Fortress, were provided by Stokes Seeds Ltd., Ontario, Canada and Asgrow Seed Co., Ontario, Canada, respectively.

### *Field evaluations*

The study was carried out on muck soil at the Holland Marsh, Ontario (lat. 44° 15' N, long. 79° 60' W) under natural OM pressure. As seed stock allowed, 19, 24 and 18 direct seeded onion lines were evaluated in 1995, 1996 and 1997, respectively. In trials using transplanted onions, 20 lines (1996) and 17 lines (1997) were assessed. Seed for the lines missing from the transplant onion trials was received in time for direct seeding (May) but not early enough for starting in the greenhouse (March or April). Fortress and Norstar were used in both seeded and transplanted assays as commercial lines for comparison purposes.



The onion lines and selected commercial cultivars were direct seeded (V-Belt push seeder, Mechanical Welding Co. Ltd, Winnipeg, Man.) at approx. 40 seeds·m<sup>-1</sup>, on 8, 16 and 21 May in 1995, 1996 and 1997, respectively. In all years, the initial stand was ascertained after seedling emergence, prior to OM adult emergence as determined by catches on yellow sticky traps. Transplants grown in a greenhouse were seeded on 10 April and 24 March in 1996 and 1997, respectively, and planted out by hand on 21-24 and 13-15 May, respectively.

Plots were set out in a randomized complete block design with 3 replicate blocks per line in 1995 and 4 replicate blocks per line in 1996 and 1997. Each direct seeded replicate consisted of 2 rows (42 cm apart), 3 m (1995) or 2 m (1996 and 1997) in length. Transplanted replicates consisted of two rows (approx. 42 cm apart), 4 m (1996) and 5 m (1997) in length. Transplants were planted at 10 cm spacing in both years. Crop management procedures followed standard cultivation practices (McDonald et al. 1997).

Field evaluations included only losses attributed to OM damage. Seedling loss from first generation maggots was recorded once a week. In all years, stand loss evaluations were initiated after the peak of onion fly catches on yellow sticky traps placed in other onion plots close to the resistance trial (28, 22, 24 June in 1995, 1996, 1997, respectively) and terminated in mid-July. Seedlings with symptoms of OM damage were removed to confirm the presence of maggots or characteristic damage at the base of the plant. For all treatments, final plant stand and onion bulb damage were recorded at harvest (for seeded onions: 29, 18, 30 September in 1995, 1996 1997, respectively and 27-29 August for transplanted onions in both 1996 and 1997).

#### *Statistical analysis*

The sum of counts from each evaluation week was divided by initial stand count to calculate percent of seedling damage due to first-generation maggot. Final percent onion damage was calculated by dividing the number of OM damaged (non-marketable) onions obtained at harvest by final stand count and multiplying by 100. The biennial nature of onion seed production did not permit the availability of all lines each year. Therefore, statistical analyses were performed on within year data, except where damage levels between the same lines in two years were investigated by correlation analysis.

In order to compare groups of related lines from year to year, the mean damage for lines within a year were standardized. A selected mean was subtracted from the year mean, and the resulting term divided by the standard deviation for the year. A single average mean was then obtained from all the related means in a year for series starting with terms such as PS WR or XPH. Means that are lower than the year mean result in a negative number, means higher than the year mean result in a positive number.

Percent data were arcsine transformed as described by Sokal and Rohlf (1995) and analyzed using Analysis of Variance (ANOVA). Comparisons among means were performed with Fishers Protected Least Significant Difference multiple range test, to allow for pair-wise comparisons between means (GLM, Post Hoc Multiple Comparisons, Bivariate Correlations, SPSS<sup>R</sup> for Windows<sup>TM</sup>, release 10.0, SPSS Inc., U.S.). Pearson Correlation analysis was used to examine the relationship between variables. (Statistix for Windows, Analytical Software, Tallahassee, FL). A type 1 error rate of  $\alpha = 0.05$  was set for all statistical tests.

## **Results**

### *Evaluation of direct seeded lines in 1995, 1996, and 1997*

Differences in OM damage to seedlings were found in each year (Tables I, II and III), however, the differences in bulb damage at harvest were significant ( $P = 0.002$ ) only in 1995 (Table I), and



TABLE I. Onion maggot damage to seeded onion breeding lines and cultivars at the Holland Marsh, Ontario, 1995.

Line/Cultivar	Damaged seedlings (%)		Damaged bulbs at harvest <sup>3</sup> (%)	
PS WR 458	8.2	a <sup>1</sup>	21.1	e
W 457 b	10.5	a	15.0	de
W 454 b	13.2	ab	12.6	cd
Norstar	16.2	abc	4.8	ab
XPH 150 55	20.0	a-d	11.7	b-d
PS WR 459	20.1	a-d	6.6	abc
PSR 45 89 94	21.0	a-d	7.4	abc
W 458 b	21.3	a-e	10.4	a-d
XPH 150 58	22.7	a-f	14.5	de
PSR 45 96 94	23.4	a-g	13.2	cd
PSR 45 92 94	23.5	a-g	9.4	a-d
Fortress	25.0	a-g	3.8	a
XPH 150 59	28.2	b-h	13.0	cd
W 459 b	29.5	b-h	4.3	a
PSR 45 90 94	32.0	c-h	4.1	a
PSR 45 93 94	36.8	d-h	8.4	a-d
PSR 45 91 94	38.1	e-h	9.4	a-d
PSR 45 94 94	38.6	fgh	4.8	ab
XPH 150 56	40.1	gh	8.4	a-d
XPH 150 57	42.7	h	6.9	abc
PSR 45 95 94	43.6	h	8.4	a-d
Overall Mean Damage <sup>2</sup>	26.6	b	9.4	a
Standard deviation	10.2		4.4	

<sup>1</sup> Means in columns (non transformed data) followed by the same letter are not significantly different ( $\alpha=0.05$ ); Fishers Protected LSD).

<sup>2</sup> Means in the row followed by the same letter are not significantly different (Total df = 123, F for growth stage = 143.91,  $P<0.0001$ ).

<sup>3</sup> Pearson correlation coefficient between first generation OM damage to seedlings and bulbs at harvest :  $r= -0.47$  ( $P<0.0001$ ).

TABLE II. Onion maggot damage to seeded and transplanted onion breeding lines and cultivars at the Holland Marsh, Ontario, 1996.

Line/Cultivar	Damaged seedlings(%)				Damaged bulbs at harvest <sup>4</sup> (%)			
	direct seeded		transplanted		direct seeded		transplanted	
PSR 45 93 94	0.2	a <sup>1</sup>	9.0	a-d	2.4	NS <sup>2</sup>	8.4	NS <sup>2</sup>
PS WR 458	1.0	a	4.0	ab	6.4		5.7	
(W) (429a x 454x455b)	1.3	a	7.8	a-d	5.5		10.1	
Fortress	1.5	a	7.8	a-d	3.6		11.6	
PSR 45 89 94	1.8	a	3.9	a-d	2.8		8.1	
W 454 b	2.0	a	6.4	a-d	6.5		3.5	
PSR 45 90 94	2.2	ab	4.2	a-d	4.0		2.7	
W 458 c	2.3	ab	2.8	abc	4.1		4.3	
W 459 c	2.6	abc	10.9	c-e	3.8		9.3	
W 457 c	2.7	abc	5.9	a-d	4.4		10.0	
(W) (440a x 458)x459c	3.1	abc	2.4	ab	5.1		4.9	
PSR 45 94 94	3.2	abc	2.9	ab	3.1		5.8	
PSR 45 96 94	3.3	abc	11.2	de	3.9		7.2	
PS WR 459	3.4	a-d	2.3	ab	5.3		4.5	
PSR 45 91 94	3.5	a-d	8.3	a-d	2.5		12.6	
PSR 45 95 94	3.6	a-d	10.5	b-e	4.9		12.2	
W 456 c	4.0	a-d	23.3	f	1.8		—	
PSR 45 92 94	5.2	a-e	6.1	a-d	2.1		12.1	
XPH 150 55	6.1	b-e	—		4.5		—	
Norstar	6.6	b-e	1.0	a	5.1		6.3	
(W) (434a x 457)x458c	6.8	b-e	2.9	abc	4.4		2.3	
XPH 150 59	9.1	b-e	—		5.8		—	
XPH 150 57	9.4	cde	—		3.9		—	
XPH 150 58	10.3	de	—		5.6		—	
(W) (434a x 455)x456c	11.1	e	18.1	ef	5.7		14.5	
XPH 150 56	12.1	e	—		4.5		—	
W 455 b	—		3.2	a-d	—		—	
Overall Mean Damage <sup>3</sup>	4.4	a	7.1	b	4.3	a	7.8	b
Standard deviation	4.9		8.0		3.0		7.7	

<sup>1</sup> Means in columns (non transformed data) followed by the same letter are not significantly different (a=0.05); Fishers Protected LSD, ANOVA of each variable separately.

<sup>2</sup> NS not significant (a =0.05)

<sup>3</sup> Means in the row followed by the same letter are not significantly different (a = 0.05), ANOVA of all variables (374 total df, *F*-test for planting method = 42.59, *P* =<0.0001.

<sup>4</sup> Pearson correlation coefficient between first generation OM damage to seedlings and bulbs at harvest for transplanted onions *r* = 0.75 (*P*<0.0001).



TABLE III. Onion maggot damage to seeded and transplanted onion breeding lines and cultivars at the Holland Marsh, Ontario, 1997.

Line/Cultivar	Damaged seedlings(%)				Damaged bulbs at harvest <sup>4</sup> (%)			
	direct seeded		transplanted		direct seeded		transplanted	
PS WR 456	5.4	a <sup>1</sup>	5.3	ab	27.8	NS <sup>2</sup>	15.2	a
W 459 c	9.4	ab	5.3	ab	20.2		18.4	a
W 456 c	9.7	ab	12.6	abc	30.8		33.5	ab
Fortress	13.0	abc	5.8	ab	39.4		14.9	ab
XPH 150 55	13.8	a-d	—		27.5		—	
PS WR 457	14.1	a-d	1.7	a	27.1		9.7	a
W 461 b	14.1	a-d	5.8	ab	31.4		16.0	ab
PS 650 00 96	14.3	a-d	2.1	a	24.6		9.2	a
W 458 c	15.4	a-d	12.4	abc	39.1		31.7	ab
W 454 b	15.4	a-d	21.2	c	53.9		57.5	b
W 457 c	16.8	a-e	14.2	bc	30.8		34.1	ab
W 455 b	17.6	a-e	21.8	c	48.6		54.3	b
PS 650 02 96	20.3	b-f	8.6	ab	32.0		22.9	a
(W) (434a x 457) x 458c	22.1	b-f	7.3	ab	34.6		18.0	a
Norstar	26.0	c-g	8.8	ab	29.6		18.4	a
(W) (440a x 458) x 459c	26.3	d-g	8.3	ab	29.3		17.3	a
(W) (429a x 454) x455b	29.3	efg	10.9	abc	26.9		30.3	ab
PS 650 01 96	33.2	fg	4.2	ab	33.8		15.6	a
(W) (434a x 455) x 456c	34.5	gh	8.9	ab	28.4		20.2	a
PS 650 03 96	46.6	h	2.9	ab	36.1		10.1	a
Overall Mean Damage <sup>3</sup>	19.9	ab	8.8	a	32.7	c	23.5	ab
Standard deviation	9.3		8.2		16.0		21.2	

<sup>1</sup> Means in columns (non transformed data) followed by the same letter are not significantly different (a=0.05); Fisher’s protected LSD)

<sup>2</sup> NS - not significant (a = 0.05)

<sup>3</sup> Means in the row followed by the same letter are not significantly different (a = 0.05), ANOVA of all variables (total df = 303, F-test for planting method 37.39, P<0.0001).

<sup>4</sup> Pearson correlation coefficient between first generation OM damage to seedlings and to bulbs at harvest in transplanted entries : r = 0.95 (P<0.0001).

for onions grown from transplants in 1997 (*P* = 0.049, Table III). Average levels of seedling damage in 1995 and 1997 were similar while damage was considerably lower in 1996. The average levels of damage to mature bulbs also varied from year to year (Tables I, II and III).

In 1995, the lines with the least seedling loss were PS WR 458 and W457b (Table I). Highest seedling losses were observed in lines XPH 150 57 and PSR 45 95 94. Most lines exhibited seedling losses of between 13.2 % and 40.1 % with few significant differences. Bulb damage as a result of OM feeding also differed among the lines (*P*=0.001).

In 1996, the lines with the least seedling loss were PSR 45 93 94, PS WR 458, (W)(429ax454x455b), Fortress, PSR 45 89 94 and W 454b (Table II). Highest seedling losses were

observed in lines XPH 150 58, (W)(434ax455)x456c and XPH 150 56. Most lines exhibited seedling damage of between 2.2 % and 9.4 % but the differences among most of these lines were not significant. There were no differences in OM damage to bulbs.

In 1997, the line with the lowest seedling loss was PS WR 456 (Table III). Highest seedling loss was observed in line PS 650 03 96. Most lines exhibited seedling losses of between 9.4 % and 33.2 % but differences among most of these lines were not significant. OM damage to bulbs was not different among lines, but damage in 1997 was 33.2% compared to only 4.3% in 1996.

First generation OM damage was not related to damage at harvest across most lines (Tables II, III), except in 1995 when seedling losses were negatively correlated with bulb damage ( $r = -0.47$ ,  $P < 0.0001$ , Pearson correlation, Table 1). In 1995, maggot damage to bulbs was lower in most lines when compared with first generation OM damage to seedlings. However, lines PS WR 458 and W 457 b, which exhibited the lowest seedling loss, had the highest bulb damage (Table I). In the following years, low OM seedling damage in PS WR 458 (1996) and PS WR 456 (1997) was followed by high and mid-range levels of OM damage at harvest, respectively (Tables II, III).

In all years, OM damage levels in both commercial cultivars did not significantly differ from most breeding lines. Fortress and Norstar exhibited intermediate levels of seedling loss and bulb damage at harvest (Tables I, II and III).

Seed of all lines was not available each year. Pearson correlation of the lines that were the same showed no correlation between mean seedling loss as a result of OM damage of the 16 lines that were the same in 1995 and 1996 ( $r = 0.07$ ,  $P = 0.78$ ), the 12 lines that were the same in 1996 and 1997 ( $r = 0.29$ ,  $P = 0.35$ ) or the 7 lines that were the same in 1995 and 1997 ( $r = -0.59$ ,  $P = 0.16$ ). No relationships were identified in bulb damage between any of the trials over the three years.

#### *Evaluation of transplanted lines in 1996 and 1997*

Differences among transplanted lines and cultivars for OM damage to transplanted seedlings within years were significant ( $P = 0.035$ , 1996 and  $P = 0.032$ , 1997, Tables II and III); however, differences in bulb damage at harvest were significant only in 1997 ( $P = 0.037$ ) (Table III). Average levels of OM damage to transplants were similar in 1996 and 1997. Average levels of damage to mature bulbs were different, 7.8 % in 1996 and 23.5 % in 1997 (Tables II and III).

In 1996, the line with the lowest transplant seedling loss was Norstar (Table II). Highest transplant seedling loss was found in the three lines, PSR 45 96 94, (W)(434ax455)x456c and W 456c, which had significantly higher damage than a group of six lines, including Norstar. Most of the lines exhibited levels of seedling damage of between 3.9 % and 10.9 %, but the differences were not significant. There were no differences in maggot damage to bulbs in 1996.

In 1997, the lines with the lowest transplant seedling losses were PS WR 457 and PS 650 00 96 (Table III). Highest transplant seedlings losses were observed in lines W 454 b and W 455 b. A group of 14 lines, including Norstar, had significantly less damage than these two lines. Most of the lines exhibited levels of seedling damage between 1.7% and 10.9% but the differences were not significant. Bulb damage as a result of onion maggot feeding differed significantly among lines ( $P = 0.037$ ). The lowest levels of bulb damage in onions from transplants were found in lines PS 650 00 96 and PS WR 457, the same lines that had the lowest seedling loss. Bulb damage in these lines was significantly lower than in lines W 455b and W 454b, which had the highest damage.

OM damage levels to transplanted seedlings of both commercial cultivars did not differ significantly from most of the tested lines (Tables II, III). In 1996, Norstar had the lowest maggot damage, but the level was not significantly different from 16 other lines. Fortress had moderate



damage. In 1997, maggot damage in Norstar and Fortress transplanted seedlings was intermediate, as was damage to bulbs at harvest, and did not differ significantly from any of the tested lines.

#### *Evaluation of planting method and growth stage*

Analysis of variance of arcsin transformed data of percent seedling and bulb damage in direct seeded and transplanted onion lines and cultivars within years revealed that levels of OM damage varied with planting method ( $P = 0.0001$  in 1996 and  $P = <0.0001$  in 1997), but the trends were opposite (Tables II and III). Levels of OM damage were lower on direct seeded onions in 1996, but higher in 1997.

Mean damage to direct-seeded seedlings and mature bulbs in 1995 and 1997 was significantly different ( $P < 0.0001$  in both years) (Tables I and III). In 1995 seedlings had higher OM damage, but in 1997 OM damage was lower. There was no planting method (direct-seeded or transplanted) by growth stage (seedling or bulb) interaction in 1996 or 1997. No correlation between maggot damage in direct seeded and transplanted lines and cultivars was found for first generation damage. In 1997, bulb damage in seeded and transplanted onions was correlated ( $r = 0.71$ ,  $P < 0.0001$ , Pearson's correlation). When untreated onions were grown from transplants, there was a positive correlation between first generation onion maggot damage and damage to bulbs, ( $r = 0.75$ ,  $P < 0.0001$  and  $r = 0.95$ ,  $P < 0.0001$ , 1996 and 1997, respectively). This was not the case for direct seeded onions.

#### **Comparisons of series of lines**

Because of the year to year differences in damage levels, means of selected onion lines within groups or series were standardized to allow for comparisons from year to year. Lines in the PS WR series had the lowest OM damage in direct seeded onions in 1995 and 1997, and the second lowest in 1996. When the means of these PS WR lines in each trial were standardized, they were consistently negative (-1.22, -0.48 and -1.09, for direct seeded onions, 1995, 1996 and 1997, respectively). Similar results were found in the onions grown from transplants (standardized means of -0.50 and -0.65, 1996 and 1997). The PS WR series was the only one where all of the standardized means were consistently negative, indicating that all were below the year mean for the seeding method. In contrast, standardized means of lines in the XPH150 series were positive (higher than the year mean) in 1995 (1.45) and 1996 (1.16) but the single line tested in 1997 was below the year mean (-0.65). Means of lines in the W series (W454 to W459) were lower than the year mean for most of the direct seeded trials (-0.79, -0.37 and -0.63 in 1995, 1996 and 1997, respectively) but levels of OM damage were greater than the year mean for onions grown from transplants (0.21 and 0.70 in 1996 and 1997).

#### **Discussion**

These field experiments confirmed that different levels of resistance to onion maggot damage could be identified in *A. cepa*. The varying levels of damage from year to year in these trials have also been reported in other studies on OM and *Allium* relationships (Ellis and Eckenrode 1979; McFerson et al. 1996; Eckenrode and Walters 1997). Screening of 37 entries over a 3-year period revealed that onion breeding lines were generally susceptible to OM attack and in most cases damage levels did not significantly differ from those found in commercial cultivars. Some entries exhibited moderate resistance to maggot damage when compared with other lines and cultivars, but none consistently resisted damage at a level that would be acceptable for commercial onion production.



As significant differences among levels of OM damage were found, some degree of resistance to OM damage may exist in certain lines. For example, lines from the PS WR series consistently showed the lowest OM damage at the seedling stage although the response was not as consistent at the harvest stage. Plant breeders could focus on the onion lines in this series to continue to investigate and improve the level of onion maggot resistance in onions.

Differences in levels of OM damage to onions and other *Allium* species are generally attributed to preference displayed by the females for oviposition sites (Loosjes 1976). Stand density in onions is not supposed to affect numbers of eggs per onion (Perron 1972), but Eckenrode and Walters (1997) reported a significant correlation between stand density and OM damage, which led them to assess onions grown from transplants, in order to achieve uniform stand. If high stand density does play a role in attracting female onion flies, this could contribute to the differences seen in damage levels between seedling and bulb onions in 1995. Onion lines that had low levels of seedling damage, which usually kills small onions, would have a denser stand later in the season, which might be more attractive for oviposition. Our data demonstrated that percent seedling loss from OM damage is related to bulb damage in onions grown from transplants but not from direct-seeded onions. Stand density tends to be more uniform in onions grown from transplants.

McFerson et al. (1996) also reported differences between OM resistance levels at the seedling and mature plant stages. The results of their study showed that some *Allium* accessions sustaining minimal damage as seedlings were nonetheless heavily damaged as mature plants by later generations. According to Perron (1972) undamaged, fully developed onions are not attacked by onion maggots, but onions with heavy, flaccid growth are known to be very attractive for oviposition (Loosjes 1976) so the phenology of larger or mature onions could influence damage levels.

Significant differences were found in levels of OM damage levels between direct seeded and transplanted lines. Harris et al. (1987) proposed antixenotic growth stages in onion and suggested that onion plants in certain growth stages were less preferred as suitable oviposition sites for onion flies due to differences in stem basal diameter. The results of Ellis et al. (1979) and Harris et al. (1987) strongly suggest that plant size plays an important role in host selection by *D. antiqua* and resulting levels of damage. Thus, plant size during the peak oviposition period could influence relative results. In this study, the onions grown for transplants in 1997 were started in the greenhouse 17 days earlier than in 1996 and planted out one week earlier, while the peak of onion fly catches on the sticky traps was two days later in 1997 than in 1996. Thus, the onion plants would be larger in 1997 when the onions flies emerged and began oviposition.

The differences in resistance to onion maggot damage in *A. cepa* reported here suggest that a search for *A. cepa* resistance to OM damage should be continued; however, seeded and transplanted entries should be studied separately since planting method can affect resistance ranking.

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## CONTACT TOXICITY OF AZINPHOSMETHYL AND ENDOSULFAN TO FIELD-COLLECTED STRIPED CUCUMBER BEETLE, *Acalymma vittatum* (F.)

J.K. MACINTYRE-ALLEN<sup>1</sup>, J.H. TOLMAN<sup>2</sup>,  
C.D. SCOTT-DUPREE<sup>1</sup>, S. A. HILTON<sup>2</sup> and C.R. HARRIS<sup>1</sup>

Striped cucumber beetle (SCB), *Acalymma vittatum* (F.), is a serious pest of cucurbit crops with an economic value exceeding \$24 million in Ontario in 2001 (Anonymous 2003). For many years foliar application of endosulfan (THIODAN® 4EC [1.5 L/ha]) and azinphosmethyl (GUTHION® 240SC, SNIPER® 240E [2.25 L/ha]), cyclodiene and organophosphorus insecticides respectively, has been the principal method for SCB-control by commercial Ontario growers of squash, cucumbers, melons and pumpkins (OMAF 2002).

In 1999, as a result of the increasing concern of Ontario growers about the decreasing effectiveness of these insecticides in the field (Anonymous 1999), the susceptibility to endosulfan and azinphosmethyl of SCB-populations from 11 representative Ontario cucurbit fields was surveyed. Individual field-collections of SCB were maintained in 30 cm<sup>3</sup> mesh cages in walk-in insectaries (25 ± 1°C; 65 ± 5% RH; 16L:8D) at SCPFRC-London. All bioassays were performed within 48 hours of collection; due to low numbers, only two bioassays, each comprising 2 x 10 insects, were completed at each concentration for each field-collected population.

Groups of 20 adult SCB were anaesthetized with CO<sub>2</sub> for 10 seconds in clean, waxed pasteboard cups. Ten anaesthetized SCB were subsequently transferred to 9 cm Petri dishes and placed in the Potter spray tower. Five ml aliquots of the desired concentration of each technical grade insecticide solution ([1] endosulfan - 97.9% purity, Aventis CropScience Canada, Regina, SK; and [2] azinphosmethyl - 97% purity, Bayer Inc. Agriculture Division, Crop Protection, Toronto, ON) in 19:1 acetone-olive oil (Harris & Turnbull 1986) were then sprayed onto the beetles. Treated SCB were transferred into clean pasteboard cups containing a dental wick (4 cm long x 1 cm dia.) dipped in RO-water. Control insects treated with acetone-olive oil were included in each test. A glass Petri dish lid prevented SCB-escape. Bioassays were held at 27 ± 1°C and 65 ± 5% RH under continuous light. Mortality was assessed after 24 hrs; data were corrected for mortality in control bioassays (<15 % for all cases) using Abbott's correction (1925).

While limited numbers of field-collected SCB precluded statistical comparison of toxicity among populations, some trends were apparent. Azinphosmethyl was one order of magnitude more toxic than endosulfan (Table I). In population one, a few individual SCB survived the highest applied concentration of both insecticides (Table I), indicating that this population should be monitored more closely over the next few years. Finally, there did not appear to be any major differences among the other populations in toxicity of either endosulfan or azinphosmethyl. With the possible exception of population one, these data may indicate that reported SCB-control failures were not due to the development of insecticide resistance but were rather a result of short persistence of foliar insecticides on rapidly growing cucurbit-seedlings (MacIntyre-Allen et al. 2001). The collected information does, however, provide baseline data for comparison should Ontario SCB-management problems develop in the future.

<sup>1</sup>, Dept. Environmental Biology, University of Guelph, Guelph, ON, Canada N1G 2W1

<sup>2</sup> Agriculture and Agri-Food Canada, Southern Crop Protection and Food Research Centre (SCPFRC), 1391 Sandford St., London, ON, Canada N5V 4T3.



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TABLE I: Corrected % mortality of eleven populations of striped cucumber beetle, *Acalymma vittatum* (F.), collected from Ontario cucurbit-fields in 1999 and treated with endosulfan and azinphosmethyl.

Pop'n No.	Average Corrected % Mortality at Indicated Concentration (ppm)							
	1.0 <sup>1</sup>	3.3	10	33	100	330	1000	3300
Endosulfan:								
1	— <sup>2</sup>	— <sup>2</sup>	— <sup>2</sup>	5	13	43	77	85
2	--	--	--	36	28	89	84	100
3	--	--	--	0	16	53	90	100
4	--	--	--	0	0	65	75	90
5	--	--	--	0	5	47	68	100
6	--	--	--	0	24	36	95	90
7	--	--	--	0	6	68	90	100
8	--	--	--	15	45	65	85	100
9	--	--	--	0	5	48	82	95
10	--	--	--	0	22	6	77	100
11	--	--	--	0	10	5	50	100
Azinphosmethyl:								
1	3	3	8	45	85	— <sup>2</sup>	— <sup>2</sup>	— <sup>2</sup>
2	9	0	100	100	100	--	--	--
3	0	0	42	100	100	--	--	--
4	0	0	70	100	100	--	--	--
5	0	0	37	100	100	--	--	--
6	15	0	33	100	100	--	--	--
7	0	0	21	100	100	--	--	--
8	11	16	47	90	100	--	--	--
9	* <sup>3</sup>	*	*	*	*	*	*	*
10	0	5	50	65	100	--	--	--
11	0	0	52	100	100	--	--	--

<sup>1</sup> technical grade insecticide dissolved in 19:1 acetone:olive oil to establish stock solutions

<sup>2</sup> concentration not tested

<sup>3</sup> Population not tested





## THE AGROECOLOGY OF CARABID BEETLES

J. M. HOLLAND [ed.] 2002.

Intercept Ltd, Andover, UK pp. 356 + xiv. ISBN 1-898298-76-9, £67.00.

This volume arose out of a session on polyphagous predators, held at the Entomological Society of America meeting at Atlanta in 1999. At first sight, the book is similar to compilations of the proceedings of the triennial European carabidologists' meetings. For example, the authorship is decidedly European in emphasis with only four of 17 authors having institutional affiliations outside Europe. However, an important difference is that the carabidologists' conferences feature new research results, whereas — with a few exceptions — the chapters in this volume are quite thorough literature reviews. The compilation therefore provides a comprehensive overview of the topic as it was in 1999.

The first chapter, "Carabid beetles: their ecology, survival and use in agroecosystems", is by the editor. This chapter is the most Eurocentric in the book. A tabulation of "the most common species found in arable land" relies solely on European sources and omits several species of importance in the Nearctic. Larochelle's lists of natural enemies of carabids are used extensively, but most other North American work is ignored. The "ecology" portion of the chapter is a quite brief and selective update of Thiele (1977). The "survival" component is dealt with in a section detailing biotic and abiotic influences on populations with the heading "Population regulation". Many of the factors discussed in this section are not regulatory in the strict sense of population dynamics. The "uses" of carabids identified are as agents of pest control, as food for vertebrates, and as bioindicators; of these, the first and third receive attention in subsequent chapters.

The second chapter is by M.L. Luff and considers the attributes of carabid assemblages in agroecosystems. The chapter analyses major data sets including SCARAB, an experimental assessment of effects of intensive pesticide use carried out in 108 half-fields in Britain, and Luff's own compilation of 119 published species lists from Europe, North America and Japan. The analysis reaffirms —and broadens to new regions— Thiele's (1977) finding that carabid assemblages in crops typically have about 30 species. Luff identifies and characterizes the ecology of six genera that dominate in terrestrial cropping systems. He also demonstrates that variation in carabid assemblages in crops is largely attributable to site, year and crop plant, and that pesticides or other agronomic management practices are of subsidiary importance.

The next five chapters, occupying over 40% of the book, review literature on carabids as natural enemies of crop pests. Three chapters address aspects of carabid diets, and the following two assess evidence for control of invertebrate pests and weeds respectively. Toft and Bilde separate dietary items on the basis of food value, as judged by the diet's effect on carabid fitness; they conclude that cereal aphids, although frequently considered to be controlled by carabids, are a low quality diet. This and other examples demonstrate that we know little about carabid prey choice and so lack a basis for quantitative assessments of pest consumption in agroecosystems. Ingerson-Mahar reviews carabid morphology in relation to diet, and gut dissection as a method of dietary assessment. This is the only chapter in which entomological terminology might deter the non-specialist agroecologist: this problem could have been alleviated by clearer, more effectively labelled, figures. Symondson's chapter provides a summary of the rapidly developing fields of immunological and molecular methods of dietary assessment, and is made more useful by its inclusion of references up to 2002. Those familiar with the work by Hagley and colleagues on carabids as predators of apple pests may be dismayed to note that Ingerson-Mahar refers to Hagley as "Hagely", and that Symondson alleges that Allen and Hagley's publications on predation of tortricids and tephritids deal with *Heliothis zea*!



Sunderland presents a comprehensive worldwide review (to 2002) of evidence that cropland carabids consume invertebrate pests (by scavenging or predation), that they kill invertebrate pests, and that they, alone or as part of a larger natural enemy complex, affect invertebrate pest populations. Presentation of the information in tables makes it very accessible, although by now many of the best examples are familiar as they were also used in the chapters on carabid diet. Sunderland concludes that, with some exceptions, “there is little evidence that trophic generalist carabids can, by themselves, make a significant impact on pest populations” (p. 201) but “There is more evidence that, when carabids form part of an assemblage of generalist predators, the assemblage as a whole can often reduce pests to a significant degree”. Tooley and Brust’s chapter on weed seed predation, although parallel in apparent niche to the chapter by Sunderland, adopts a very different approach. It provides a general review of the topic of post seed-shed weed seed predation by carabid beetles. Although it is concluded that weed seeds are consumed by carabids, lack of information on prey selection by carabids and on implications of seed mortality for weed population biology make conclusions parallel to those of Sunderland impossible.

The remaining four chapters deal with various aspects of carabid ecology in the context of the agricultural landscape. Hance briefly reviews the influence on carabids of crop management practices, including crop selection and arrangement, cultivation, agricultural chemicals, and natural enemy refuges. This is followed by Holland et al., who address the same topics from the opposite viewpoint: “Are carabids indicators of the environmental impacts of crop management practices?” This chapter presents carabid-related results from the SCARAB project on pesticide effects (referred to above), and from the LINK integrated farming systems study, in which conventional and low agrochemical input farming systems were compared. This chapter is not the epitome of reader-friendly communication: in addition to SCARAB and LINK, the reader must grapple with several more acronyms, some of inconstant meaning, must deduce the meaning of a table (9.2) that lacks adequate explanations and, if interested in important methodological details, must seek them in project reports to various UK government agencies. It is difficult for the reader to reach a balanced evaluation of the outcomes of the LINK and SCARAB projects: for each of them, the data presented are selected because they show the greatest responses by carabids and so are by no means typical. The authors conclude that, with the exception of the fields they choose to highlight, neither project shows evidence of effects of pesticides on carabids.

Lee and Landis review the management of non-crop refuges for carabid beetles, including “beetle banks” which are raised grassy strips within crop fields. While such refuges contain high densities of carabid beetles that are often in better physiological condition than those in crops, it is not clear whether the refuges operate as sources or sinks for carabids, and to what distance their influence extends into the crop. While the authors do address the issue of how to manage refuges, they admit that a major limitation of adoption is the absence of clear evidence that they improve pest control.

The final chapter, by Thomas et al., considers the spatial distribution of carabid beetles in agricultural landscapes. There is a discussion of methodology and results of studies of distribution of carabids in and around agricultural fields, and within individual fields. At the latter scale, the authors demonstrate from their use of SADIE (Perry 1995) to describe spatial patterns and measure their association with potential causative factors. They contend that SADIE provides a tool for learning how to manage habitats for biodiversity, conservation or pest control.

Overall, the literature reviews are by far the most valuable components of the book, as most of them provide comprehensive summaries of the state of knowledge. Most figures and tables are well presented and provide useful information in support of the text. Further editing would have removed some of the typographic and spelling errors, and helped the non-anglophones to present their knowledge more effectively. The editor might also have negotiated with authors to reduce the

degree of overlap between chapters: in addition to the repetition in the section on diet, "beetle banks" were described in three chapters. Such repetition may not affect the average user of this book: only reviewers and editors are likely to read it from end to end. The average user of the book is likely to fall into one of three categories: the carabid specialist, the crop entomologist with an interest in pest management with natural enemies, and the agroecologist interested in how production practices affect non-target organisms. For the non-entomological agroecologist, it is sufficiently free of entomological terminology to be quite approachable. Carabids are probably the best-studied non-pestiferous insects of agroecosystems, and the book provides a valuable summary of our knowledge about them and, salutarily, reveals how much remains to be discovered.

N. J. Holliday  
Chair, Agroecology Program &  
Head, Department of Entomology  
University of Manitoba  
Winnipeg Manitoba

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## BIOLOGY OF LEAF BEETLES

PIERRE JOLIVET and KRISHNA K. VERMA 2002.

Intercept Limited, Andover, England. 332 pp. ISBN 1-898298-86-6. Hardcover, \$162.00 US.

This book aims to be a summary of the present knowledge of the Chrysomelidae. The volume contains 12 chapters: after an introductory chapter there are chapters titled Classification, Paleontology, Food Plants and Evolution, Food and Feeding, Developmental Stages, Ecology, Biogeography, Island Faunas, Defense Strategies, Anatomy, Reproduction, Association with Other Organisms, and finally Phylogeny of the Subfamilies. I was looking forward to this book because of the reputation of the authors and because of the potential utility for students. (I should note that I am an author of two chapters in an upcoming book edited by Dr. Jolivet and others; one chapter is a phylogeny of the subfamilies of Chrysomelidae).

This book contains much useful information and it is abundantly illustrated. It is very helpful to have so many illustrations of taxa and morphological features between one set of covers. In general, this text gives a fairly complete overview of the topics discussed. For example, the chapter on Food and Feeding covers host plant evolution briefly, gives a short section on the feeding and feeding habits of each of 20 chrysomelid subfamilies recognized by the authors, followed by sections on choice of host plant and plant part, entomophagy, nematophagy, coprophagy and cannibalism, as well as a section on parallel diversification of Chrysomelidae with their host plants. This chapter is of general interest to any collector who wants to improve her collecting skills or who wants to capture a particular taxon or life stage more frequently.

The Ecology chapter, as an additional example, covers aquatic and subaquatic leaf beetles, adaptations to desert life, to alpine environments and to polar regions (including morphological, physiological and developmental adaptations). Chrysomelidae in the canopy and in caves are treated, as well as, niche separation and diapause.

Several chapters have many wonderful illustrations. The Classification chapter had a fantastic series of antennal modifications of Galerucinae. The Biogeography chapter has a plate, which provides a splendid visual review of the megamerine Sagrinae. The Paleontology chapter is also graced with many illustrations. I especially appreciate being shown a phylogenetic tree with a hypothesis of plant ordinal relationships.

The most complete and comprehensively illustrated chapters are those on Development and Anatomy. These chapters cover and illustrate all topics a beginning student really needs to know, with illustrations of almost every important feature. The treatment of the wing and wing venation was quite comprehensive and the development of the reproductive tract, especially the male genitalia, are well done. My only disappointment was that the treatment of the hard parts of the female genital system did not quite get the detailed treatment that the antennae do in chapter 2, but this is a minor point. In total those chapters were well written, complete and richly illustrated and I will assign them to my graduate students.

However, this book is not for beginners; this text has a very particular view of the phylogenetic and classification literature, which makes it misleading for the uninitiated. Moreover, it is not consistently referenced; some topics receive complete and thorough citation of the relevant literature, other topics have no citations at all, and most difficult are the topics in which the citation is incomplete but some works familiar to the authors are cited. The lack of thorough citations is general, but is especially misleading in the Phylogeny and Classification chapters.

In the three chapters dealing with phylogeny and classification (including the Paleontology chapter) it becomes obvious that the phylogenetic philosophy of the authors clearly follows Ernst Mayr and other evolutionary taxonomists. The authors tend not to cite Hennigan (phylogenetic)



systematists and when they do they may misinterpret them. This is exemplified by the following quotation discussing homoplastic characters in the Chrysomelidae.

“Crowson has also pointed out that these tendencies have appeared polyphyletically among Chrysomelidae: hence a cladistic approach, based on derived characters is not likely to yield reliable results.” (p. 9)

Here they refer to Crowson (1994) in the preface to a volume edited by Jolivet *et al.* The passage by Crowson reads, “With so many character states polyphyletic in the family, and some of them liable to secondary loss, the uncritical application of cladistic procedures in Chrysomelidae, particularly at the level of subfamilies, is likely to give unreliable results.” (Crowson 1994 p.xxii).

This type of misinterpretation of phylogenetic authors is consistent throughout the work. Additionally, the most comprehensive phylogenetic treatment of the Chrysomelidae based on morphological characters of all three life stages and all subfamilies was granted scant attention, meriting only the following passage. “Reid (1995) attempted a cladistic analysis of subfamilial relationships, and he finds Chrysomelinae, Galerucinae and Alticinae in the same clade”.

Unfortunately, the editing in the volume is also inconsistent, both in use of English vocabulary and grammar, as well as in the identification of the subfamily for a mentioned genus or species. In many places the authors are assiduous about orienting the reader to the subfamilial classification of a genus discussed, in other places the reader is on his own. In several situations, the reader may be lost if he is not familiar with the taxa or the anatomy. For example, when the Lepidopteran genus *Heliconius* was discussed, an overzealous application of the spell checker transformed that genus into the plant genus *Heliconia*, which is also discussed in several places in the book. These editorial issues are a minor distraction to an experienced biologist but would interfere with student comprehension.

The prices that I was quoted for this volume over the Internet, range between 52 and 60 English pounds or up to \$162 US. This price makes it difficult for me to recommend this book to the non-specialist, however, this is a useful reference for persons collecting broadly in the Chrysomelidae or needing a general reference to anatomy and development.

Catherine N. Duckett\*

Permanent address: Smithsonian Institution, Department of Entomology, Washington D.C. 20560 U.S.A.

Current address: \*Rutgers University, Cook College, Blake Hall, 93 Lipman Dr. New Brunswick, N.J. 08901 U.S.A.

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## 2002 ANNUAL MEETING

The **Entomological Society of Ontario** is grateful for the support received for the **Annual Meeting** held in Ottawa on 18-20 October 2002 from: AAFC-Research Branch, The CanaColl Foundation, Canadian Food Inspection Agency, The Tropical Conservancy and Canadian Museum of Nature.

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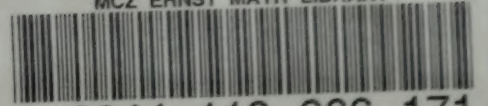
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